

SCIENCE.

FRIDAY, FEBRUARY 15, 1884.

COMMENT AND CRITICISM.

It may not be generally known that it is the duty of the National academy of sciences to examine and report upon such matters as may be submitted to it by the proper authorities of the national government. The problem is referred by the academy to a committee, composed of such of its members as are specially skilled in the science to which the subject appertains; and they consider it in the light of all accessible data, and, where necessary, submit the problem to experimental investigation and study. It is not unusual, also, to call into council experts in good standing who are not members of the academy. All these services are rendered gratuitously, only the actual expenses incurred being defrayed. It would seem as if no fairer way could be devised for obtaining an honest and intelligent opinion on the question at issue; since the government is unbiassed, and the jury untrammelled, while it consists of men whose ability and attainments are guaranteed.

Many reports have thus been presented to the government during the existence of the academy; but few seem to have attracted as much attention, or to have aroused as much feeling, as a recent report made to the commissioner of internal revenue upon the question as to the wholesomeness of glucose as an article of food. The conclusions reached are, 1°, that the manufacture of sugar from starch is a long-established industry, scientifically valuable and commercially important; 2°, that the processes which it employs at the present time are unobjectionable in their character, and leave the product uncontaminated; 3°, that the starch-sugar thus made and sent into commerce is of exceptionable purity and uniformity of composition, and contains no injurious substances;

and, 4°, that though having at best only about two-thirds the sweetening-power of cane-sugar, yet starch-sugar is in no way inferior to cane-sugar in healthfulness; there being no evidence before the committee, that maize starch-sugar, either in its normal condition or fermented, has any deleterious effect upon the system, even when taken in large quantities.

For reporting these conclusions, the members of the committee have been most severely attacked, and their honesty impugned. One of the most bitter and partisan of these attacks is contained in a recent 'leader' in the *Washington Evening star*, in which it is distinctly implied that this report favors the use of glucose in adulteration. Inspection of the report shows this deduction to be entirely without foundation; and the attack reveals the most unpardonable ignorance, or a deliberate intention to deceive. The use of glucose in adulteration is a well-known fact, and it is the duty of the commercial and legal fraternities to devise means for its prevention. The wholesomeness of glucose was a matter about which nothing was definitely known, and the fact of its being largely used in food made the matter of the gravest consequence. The consideration of this fact was the most important duty of the committee.

THE action of the New-England fish and game convention, recently assembled in Boston, should meet with cordial support in all quarters. The object of the convention was to secure uniformity in the fish and game laws of all the New-England states, and to see that these laws are so worded that they may be enforced. The present game laws, of Massachusetts at least, are in great measure a farce, as under them convictions are often impossible, even when infringement of the law is clearly proved. This is due, in part, to the varying close times in different states, — a condition of things which encourages the smuggling of ille-

gally acquired game into a neighboring state. A carefully considered draught of the proposed uniform laws has been presented to the Massachusetts legislature; and since it would be difficult to find, in all New England, persons more competent to draught such laws than those who recently came together for this purpose, it is hoped that the draught, without material change, will be accepted by the legislature. Provision is made for the granting of special licenses only to actual students, cutting off the nearly indiscriminate license-giving to young men who wish to form collections for their personal gratification, and not for true scientific study. The lobster question has become far more serious than most persons are aware. This important crustacean is now nearly extinct on our shores; so that the proposed close time, and the prohibition of the capture and sale of any lobster under one foot in length, are wise additions to the existing laws. The proposal to intrust the duties of game commissioners to the commissioners on inland fisheries, as is done in some states, is another important provision of the proposed law.

THE movement which within the last few years has caused a rapid organization of agricultural experiment-stations in various parts of the United States has developed another phase of the problem concerning the distribution of work in botanical research. The very marked development of botanical science within the last ten or fifteen years has necessitated specialization in several directions, and renders it necessary to consider which of the particular fields inviting research should remain identified with our higher institutions of learning. One of the most promising fields at the present time is to be found in vegetable physiology; but this is discovered to be naturally gravitating towards the experiment-stations and away from the colleges. This is a phase of the problem which should be carefully considered by those who have in hand the interests both of the science and of the stations; and care should be taken not only that those who are called to the charge of these important institutions should be capa-

ble of fully appreciating the importance of the interests involved in this particular branch, but that they should secure to it a position commensurate with its high character and the great possibilities which it offers in the way of practical results.

THE present season is remarkable for the brilliancy of the evening sky; the four brightest planets, Venus, Mars, Jupiter, and Saturn, being all above the horizon at once. To add to the brilliancy of the spectacle, this takes place at a time when Orion, Taurus, and others of the brightest constellations, are near the meridian, and nine stars of the first magnitude above the horizon. An additional point of interest to possessors of telescopes is, that Saturn is approaching both his perihelion and the point of greatest opening of his rings, and is therefore in that part of his orbit most favorable for study. About the middle of April an addition will be made by the simultaneous appearance of Uranus, Neptune, and Mercury, so that all eight of the major planets will be visible at the same moment. Of course a telescope will be required to see Uranus and Neptune, but the six others will be visible to the naked eye.

ENGLAND has been rejoicing in a piece of elephant worship since Mr. Barnum placed at the zoölogical gardens in London the white elephant which he recently procured from Burmah. The natives of the east affirm, and the Europeans are willing to corroborate their statements, that the body of a dead elephant, except of such as die by the rifle, is never found. Whether they never die, or betake themselves to some remote body of water before they depart this life, is a disputed point. The great esteem in which the elephant is held is said to be due to the last incarnation of Gautama, before he was born as Buddha, being that of an elephant; yet, as the Buddhists' idea of the path of beings is on through at least seven heavens to the final total annihilation, it is not perfectly clear why they should not suppose the soul to finally take refuge in an old elephant, to rest with it in its unknown grave.

LETTERS TO THE EDITOR.

Deafness in white cats.

I AM engaged upon an investigation concerning the causes of deafness; and I have therefore naturally been much interested in Mr. Lawson Tait's paper concerning deafness in white cats, published in *Nature* (vol. xxix. p. 164), and in the letter of Mr. Joseph Stevens, published in the same journal, concerning his father's breed of deaf white cats (vol. xxix. p. 237).

I have myself come across three instances of white cats with blue eyes (two in Europe and one in America), and in each case the animal was deaf.

Mr. Tait's statement, that "congenital deafness is not known to occur in any animal but the cat" is a most extraordinary one, in view of the great prevalence of congenital deafness among human beings.

Of the 33,878 deaf-mutes in the United States, more than one-half are congenitally deaf;¹ and in Europe (excepting Germany) the proportion of congenitally deaf appears to be much greater,—about four to one, according to the late Dr. Harvey L. Peet (1854).²

Why should congenital deafness among the lower animals be confined to cats, and why only to white cats?

Mr. Tait notes also an apparent association between epilepsy and whiteness in animals. He says, "Every kind of white animal I have kept as a pet has been the subject of epilepsy; and the association is suggestive when we are told, as I have been frequently, that the disease is unknown among negroes."

It is worthy of note, that deafness also appears to be less common among negroes than among white people. According to the recent census, the total white population of this country amounts to 43,402,970, and the total number of white deaf-mutes is 30,661. The colored population is given as 6,580,793, with 3,177 colored deaf-mutes (not including Chinese and Indians).

Thus, while we have one deaf-mute for every 1,416 of the white population, we have only one deaf-mute for every 2,070 of the colored people. It would be interesting to know whether the proportion of congenitally deaf is less among the colored than the white deaf-mutes.

The pallid complexion of many deaf-mutes has often been commented upon by strangers as an apparent indication of ill health. While I cannot say that I have myself observed this as a common characteristic, still my attention has never been specifically called to the point. It would be easy to test the matter by collecting into one room all the congenitally deaf pupils of some large institution, excluding those pupils who became deaf from accidental causes. A cursory examination would probably show whether there is or is not, in the human race, an association between congenital deafness and the absence of coloring-matter from the skin and hair. I trust that some of your readers may be able to throw light upon these points.

ALEXANDER GRAHAM BELL.

Washington, D.C., Feb. 4, 1884.

Radiant heat.

In a letter to *Science* of Jan. 25, Mr. Fitzgerald thinks it is possible that I am misled as to the manner in which my rotating-screens work, by reason of the complication of the arrangement. I must nevertheless continue to assert, that I think I understand

¹ See Compendium of the tenth census (1880), part ii. p. 1664.

² See American annals of the deaf and dumb, vol. vi. p. 237.

how the process I have invented operates, and cannot admit that I am in error in this until such error is pointed out. Now, Mr. Fitzgerald's demand that I should show that the heat which originally came from *B* is returned to *B* in the same direction as the heat coming from *A*, would incorrectly lead the reader to suppose that I made some such statement or supposition in the original paper, and that consequently I was misled, as he suggests. But the most superficial examination of the paper shows that I have not for a moment supposed this; as I have simply proposed to so arrange the reflecting surfaces as to return radiations from *B* through some one or more of the apertures in the screen *b*, and not necessarily through the apertures from which they originated. It necessarily follows, that I did not suppose them to be returned in a direction parallel to the radiations from *A*.

I think, then, that Mr. Fitzgerald must certainly admit that I have not made the blunder which is implied in his letter.

Again: Mr. Fitzgerald takes it for granted, apparently, that this want of coincidence in direction would be fatal to the process; whereas, in my estimation, the only question is, whether the radiations which originally came from *B* are returned to *B* or not. What their direction may be appears to me entirely immaterial.

If it is possible to show that the want of coincidence in the direction of all the rays coming to *B* invalidates the process, as Mr. Fitzgerald implies, he will no doubt be able to give a direct proof of the fact. Such proof, however, seems to me impossible; for, after the energy reaches *B*, the path by which it has arrived is of no consequence.

It goes without saying, that in this view of the matter it is quite impossible to substitute the process proposed by Mr. Fitzgerald in place of mine; as in his process these directions necessarily coincide, which in mine cannot coincide.

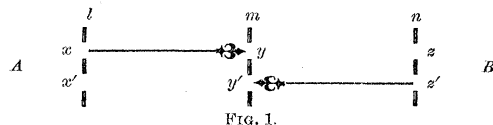


FIG. 1.

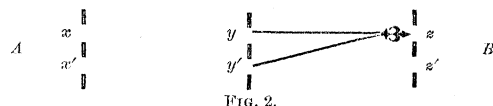


FIG. 2.

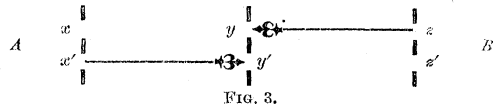


FIG. 3.

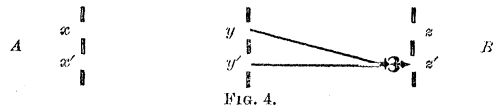


FIG. 4.

It does seem possible, however, to employ two sets of openings such as Mr. Fitzgerald has proposed, in such a way that they shall together accomplish what neither of them can effect singly. For example: let there be three fixed screens, *l*, *m*, *n*, with two sets of openings, *x y z*, *x' y' z'*, which can be opened or closed instantly; and let them all be closed except when the contrary is explicitly stated. Let each of the four equal intervals of time which we shall speak

of be the time required by the front of a ray in moving from n to m , or *vice versa*. During the first interval let x and z' alone be open. The rays between the screens at the conclusion of the first interval are shown in the first diagram. During the second interval let y alone be open, and let the reflector at y' send the ray impinging on it towards z . The situation of the rays at the end of the second interval are shown in the second diagram. During the third interval let x' and z alone be open. The rays between the screens at the end of this interval are represented in the third diagram. During the fourth interval let y' alone be open, and let the reflector at y send the ray from that point toward z' . The next interval is a repetition of the first, and so on.

It is seen that, in fact, the difference in the directions of the two rays arriving at B can be made less than any assigned finite angle, however small, by sufficiently increasing the distance between the screens, or sufficiently decreasing the space between the openings, or both.

It is possible that the above process may, from its comparative simplicity, conduce to a clearer understanding of the relations involved, though it seems inferior to the one originally proposed in some important particulars.

H. T. EDDY.

University of Cincinnati, Feb. 2, 1884.

The Greely relief expedition.

In view of the comment upon the Greely relief expedition, it may not be out of place at this early date to call attention to a neglected principle of arctic navigation which bears with full force upon the navigation of the route in question. To its adoption may be traced the success of Nares with the Alert and Discovery, and of Nordenskiöld with the Vega; to its neglect, the wreck of the Jeannette and the Proteus among a host of others.

Simply stated, it is, under all circumstances, to cling to the coast, and among its islands find protection against the floating ice. To coast along the edge of the floe, and follow the openings it offers, is a veritable siren. Of course, the principle is not applicable till after Jones's Sound is passed; but here the course is usually free.

The Eskimo knew me as

TILLOTIANIAC.

New Haven, Conn., Feb. 2.

The red skies.

I have only time to-day to reply very briefly to your editorial inquiry on p. 30, as to previous instances of red skies and volcanic eruptions.

You will find a West India instance in 1831 on p. 165 of the *Meteorological magazine* for 1883; but the most striking parallel has been pointed out by Professor Karsten of Kiel as occurring in 1783, lasting about four months, and spreading over the whole of Europe, northern Africa, and eastern Asia.

Arrangements are being made for the concentration of all collectible information upon the subject, and I shall be proud to act as the receiver of copies of any notes or records which your readers may intrust to me.

G. J. SYMONS, F.R.S.

62 Camden Sq., London, N.W.,
Jan. 25, 1884.

[We shall publish Professor Karsten's article next week.]

Aeolian ripple-marks.

On the evening of June 11, 1883, after a severe rain-storm, during which large quantities of soil were washed from adjacent fields and deposited along the

roadside, I noticed near Brodhead, Wis., a peculiar phenomenon, which may be worth recording. The mud, deposited only a few hours before, was still very mobile, and, at the point where best seen, covered an area a rod or more wide and three or four long, presenting a perfectly plane surface. The steady force of the strong wind was interrupted by occasional gusts of greater violence, each of which raised on the plastic mud-surface corrugations, which, in every detail that could be caught during their momentary existence, resembled ripple-marks formed by water, being a beautiful and distinct series of parallel ridges slightly concave toward the direction of the moulding-force. The outlines of these aeolian ripples were no sooner defined than they began to dissolve, and a minute or two sufficed to obliterate all trace of them. The phenomenon was observed several times on the same surface, and also in adjacent localities, where the consistence of the mud, and therefore the duration of the ridges, varied slightly. The ripples were best defined in the thinnest mud, though this was most favorably situated for their production; and they disappeared less rapidly where formed in the more viscous material.

This, of course, is not a radically new phenomenon, but a rare phase of the familiar action of wind on liquid surfaces.

R. D. SALISBURY.

Winchell's 'World-life.'

Will you permit me to announce that a number of errata, attributable both to author and proof-reader, have found their way into my late work on 'World-life;' and I will be glad to mail slips of corrections to any who will kindly notify me by simple postcard that they so desire?

ALEXANDER WINCHELL.

Ann Arbor, Mich.

THE LABORATORY IN MODERN SCIENCE.

THE material circumstances under which scientific discovery is prosecuted have been completely revolutionized during the last forty years. Of the immense changes that have occurred, the majority have fallen within the last fifteen, one might almost say dozen, years. It is interesting and profitable to contrast the past with the present in this respect.

Forty years ago there were very few, more properly no laboratories which we of to-day would consider even tolerable. Now every university of importance and high repute, the world over, has large suites of rooms for each department of science, and often numerous great buildings within whose walls thousands and thousands of students are daily brought face to face with the facts and laws of nature. The generation that is now gone pursued its scientific studies in incommensurable quarters, and even those were destined for the use of the professors rather than the students. Many a small, dingy, and ill-lighted room is still to be seen, where some illustrious *savant* created new knowledge,—a small square chamber, with crooked walls, low ceiling, undulating floor,

and an insufficient window: what scientific traveller abroad has not seen that working-place, where his predecessors labored at the foundations of our existing science? Is not each of its forlorn details examined with a curiosity which is half wonder, half pity? Yet in such places were made the commencements of modern science.

Nowadays discovery has more seemly abodes. The great institutes which make the pride and glory of German universities are the models now being copied everywhere. By a guess we may estimate the number of laboratories equipped and intended for research at four or five hundred. The modern laboratory is a really new institution, the evolution of which still awaits its historian. Its origin appears to have been twofold: it grew, on the one hand, out of the museums; on the other, from the private collections of apparatus and materials belonging to the professors. The earliest museums were storehouses of curiosities,¹ but during the eighteenth century they gradually acquired a more scientific character. Not, however, until this century, did any of the museums attain great size; while the gigantic dimensions which a few, like those of Berlin, London, Paris, and Washington, have reached, are the result of very recent growth. Of course, special work-rooms have to be provided for those in charge of, or who come to study, such large collections; and, since the majority of scientific museums are connected with universities, the work-rooms in many of these institutions have become laboratories for students.

A great many of the older scientific men now living, and of the previous generation, got their little and imperfect practical training in private laboratories, which were the only ones existing in the earlier part of this century. Before long a few professors introduced, through their private energy, better equipment for the benefit of their laboratory students; and, when the demands exceeded their resources, these early enthusiasts obtained subventions from the university authorities. As these appropriations were increased, the private laboratory gradually became a university enterprise. Thus, Purkinje established his physiological laboratory at Breslau; Magnus, the physical laboratory at Berlin; and Liebig, the chemical at Giessen.

A good museum is very valuable, but a good laboratory is many times more valuable. Collections of any kind have, as such, a very

limited utility, and even that only in very few sciences. The modern laboratory is almost unrestricted in its scope and possibilities. It is the most remarkable and influential creation of science in our time. It is a place well supplied with the necessary conveniences for watching and recording the special class of natural phenomena belonging to the science to which the particular laboratory is dedicated. Experience has shown that the appliances necessary for the exact observation of nature are numerous, varied, and costly: indeed, the thorough pursuit of any branch of science requires ample resources. Now, pure science does not lead to wealth: therefore students and investigators are compelled to rely upon the concentration of means and appliances in endowed laboratories to render their work possible. Association and co-operation, the characteristic social forces of our epoch, nowhere achieve more important results than in these laboratories, in which are produced the majority of current contributions to knowledge.

The expense of establishing and maintaining a good laboratory of any kind is far greater than is usually conceived. There are weights and volumes and temperatures to be measured, requiring delicate balances, graduated glasses, and fine thermometers; a great variety of glassware, lamps, stands, etc., is necessary; also reagents, standard fluids, and the like; next come the special supplies needed for the science to which the laboratory is devoted. It is astonishing how much like an assemblage of machinery the stock becomes even in those departments which require least. Next to be named is the material to work upon, which, in the natural-history sciences, is extensive, and has to be gathered from far and near. Finally, we mention as indispensable a small working-library, which ought to contain at least all those books that need to be frequently consulted, and sets of a few of the most valuable special journals. These conditions are more than fulfilled in many European laboratories, but by very, very few in this country. The architectural conditions are, on the whole, of subsidiary importance. There is no more common or egregious error than to suppose the erection of a building establishes a laboratory. In a handsome edifice something essential is often sacrificed to appearance: outside beauty is not indispensable to inside convenience. Half the cost of a building, given to endow the running-expenses of a laboratory, would in the majority of cases prove many fold more valuable.

A good scientific laboratory—that is to say, one in which original researches, as well as

¹ Of course the original 'musaeum' at the palace of Alexandria was altogether different.

mere teaching, may be undertaken (such a one as is found at universities, *de facto*) cannot be carried on properly and successfully by less than three persons. The highest officer must be the responsible director,—a man of superior ability, extensive attainments, and prolonged experience: one, in short, who has mastered his department of science, knows its possibilities and deficiencies, and is therefore capable of judging what work is most feasible and instructive for students, and what problems are best adapted for investigation. It is sheer waste for a man of such high capacity to sacrifice his whole time to the arrangement of apparatus, or the preparation of experiments for his lectures or his students: therefore it is desirable, we prefer to say indispensable, that he should have an assistant, preferably a young devotee of science, who will be fitted by his experience as an assistant to ultimately become himself director of a similar laboratory. The third person is the laboratory keeper (*diener*), who needs must be a man of some mechanical skill, so that the precious instruments may be safely intrusted to his care. He should be something more than a servant, and less than an assistant. A laboratory without this working-force cannot do much for the promotion of science, although even more modest ones may be valuable for simple instruction. A first-class laboratory, and in Germany are many such, has always a larger number of officers. There are few persons among us who appreciate the magnitude of a scientific laboratory: were it otherwise, there would not be so many petty substitutes for them.

Existing laboratories fulfil two functions,—giving education to students, and opportunity to investigators. The multiplication and enlargement of laboratories depend chiefly upon the growing recognition of the truth that first-hand knowledge is the only real knowledge. The student must see, and not rest satisfied with being told. Translated into a pedagogic law, it reads, ‘To teach science, have a laboratory; to learn a science, go to a laboratory.’ He who has never learned to appreciate a laboratory in its highest sense does not know even the meaning of ‘I know.’ We do not consider those liberally educated who have never had even a single thorough course of laboratory training. It is the laboratory which gives strength to the movement in favor of scientific education, for it opens to all the road to real living knowledge; while books by themselves lead off to the by-ways of what other men thought they knew at the time they wrote. Life and death are not more different than

are, in their ways, real and book knowledge of nature. A book, at best, is but a useful adjunct in science.

To the investigator the laboratory is, or ought to be, all in all, providing him with every thing wherewith to experiment and observe. Not only should there be on hand all the paraphernalia of research, but it must also be possible to purchase or construct the new apparatus which may be devised to meet the new requirements. Yet in no respect, perhaps, do laboratories maintain a more efficient utility than in fostering technique, by the development of new methods, and by gathering from all sources complete information concerning the available processes and means of work. Only the daily laborer at science can adequately value the knowledge of methods which is concentrated in every well-managed laboratory. In places where these requirements are fulfilled, discovery makes rapid progress; and their existence explains the present immense rapidity of scientific progress.

What a contrast between the magnificent opportunities we enjoy to-day and the meagre possibilities of fifty years ago! The change has been rendered possible by the establishment of well-fitted laboratories for the promotion of science.

TESTS OF ELECTRIC-LIGHT SYSTEMS AT THE CINCINNATI EXPOSITION.

THE commissioners of the eleventh industrial exposition held in Cincinnati in September and October, 1883, determined to undertake a series of tests of the efficiency of electrical lighting systems, and so advertised in their circulars, which were widely distributed. Special premiums were offered for the best system of arc-lighting, the best system of incandescent lighting, the best dynamo machine for arc and incandescent lighting respectively, and for the best lamp in each system.

A jury was appointed by the commissioners, consisting of T. C. Mendenhall, chairman, H. T. Eddy, Thomas French, jun., and Walter Laidlaw. The jury was instructed to make such tests and measurements as seemed desirable and were possible under the circumstances, and which would aid in arriving at a verdict upon the relative merits of the different exhibits.

The opening of the exposition took place on Sept. 5, and the close on Oct. 6. The jury was requested to make its report of the awards one week before the close of the exposition.

In response to the proposal of the commis-

sioners, four systems of electric lighting were entered for competition. The Thomson-Houston electric-lighting company submitted a system of arc-lighting; the Edison electric-lighting company, a system of incandescent lighting; and the U. S. electric-lighting company offered a system of arc-lighting, and also one for incandescent lighting. Several things conspired to make the tests less complete in some respects than was desired by those interested. The members of the jury were all engaged in professional work, and were therefore unable to devote their entire time to the tests. The dynamometers used were built after the exposition opened, and were not completed until after many vexatious delays. One of them, that upon which the most reliance was placed, was of a form recently devised, and the principles of which had never been realized in practice, except in an experimental model constructed by its inventor. Its construction on a large scale necessarily involved a good deal of experimentation. In spite of these delays, the jury was enabled to begin regular work on the evening of Sept. 25, and to make, during the succeeding ten days, such tests of the most important features of the various systems as to justify them in making the awards, whatever difference might have existed in reference to minor points, which, for lack of time, were not thoroughly investigated.

The plan adopted was substantially that upon which nearly all similar trials have been conducted. The energy consumed by the dynamo was measured by means of the dynamometers, and the electrical energy in the circuit was determined by well-known methods. This gave the efficiency of the machine as a generator. The illuminating-power of the lamps was compared, and at the same time the electrical energy which they consumed was measured. A combination of the results obtained by these two processes gives the relative illuminating-power per unit of energy consumed by the dynamo, which represents the relative commercial efficiencies of the systems. The measurements made, therefore, were of three kinds, — dynamometric, electric, and photometric; and they will be considered in the order mentioned.

Dynamometric measurements.

Two separate dynamometers were simultaneously employed in measuring the mechanical energy expended in running the armatures of the four dynamos which were tested. They have been called, from the manner of their

operation, the 'belt' and 'cradle' dynamometers respectively.

The belt dynamometer has been frequently employed before; and its manner of operation is explained by Dr. Hopkinson in *Engineering*, vol. 27, p. 403, where he gives a figure of it, and the formulae used by him in determining the power expended in certain electric-light tests. These formulae tacitly assume that the belt is perfectly flexible and without weight: for otherwise terms must be introduced into the formulae to take account of the differences of tension in the belt caused by passing the dynamometer-pulleys, and the centrifugal force generated in the belt as it leaves the various pulleys. The velocity of the belt being great, it is more than probable that such terms are required in order to deduce accurate results from this form of dynamometer.

Under these circumstances the computation of the power expended from the observations of the belt dynamometer by the theory as at present known was wholly unsatisfactory, giving results, in all except the first few tests, considerably less than the truth, and in some cases less than the electrical power in the circuit.

The cradle dynamometer, however, gave results of a much more satisfactory character. The principle of this dynamometer is a recent invention of Professor Brackett of Princeton, N.J., and, owing to its novelty and great accuracy, merits a somewhat minute description. It was built at the machine-shops of Messrs. Lane & Bodley, Cincinnati, under the superintendence of Mr. Laidlaw, from designs made by Mr. Eddy, to whom is due the arrangement of its various parts.

It consisted of a substantial platform, *cc*, fig. 1, seven feet long by four and a half feet wide, hung at each end by iron rods, *ee*, from an axis consisting of a short piece of two-and-a-half-inch shafting, *a*, which rested upon a supporting-girder, *gg*. Fig. 1 represents the framework, etc., at one end of the platform, to facilitate raising and lowering the girder *gg*, which carried the platform *cc* by means of the jackscrews *jj*, upon which *gg* rests. The uprights *bb* are guides passing through the openings *bb*, shown in fig. 2, which is intended to represent the ground-plan of *gg*, and adjacent parts of the cradle. Each girder, *gg*, was composed of two planks, held at a distance of three inches apart by blocks, *dd*, and bolted firmly together. The rods *ee* passed between the planks *gg*, and were forged to an eye which fitted the axis *a*. The axis *a* rested upon pieces of smooth boiler-plate in the upper surface of *gg*.

The uprights *bb* form part of a rigid framework, well bolted together, one side of which is seen in outline on a smaller scale in fig. 3.

A scale-beam, *ff*, made in the form of an inverted **L**, and graduated to fractions of an inch, had the lower extremity of its vertical arm fastened to the platform *cc*; while at the angle was an eye which was centred upon *a* by the screws *iii*.

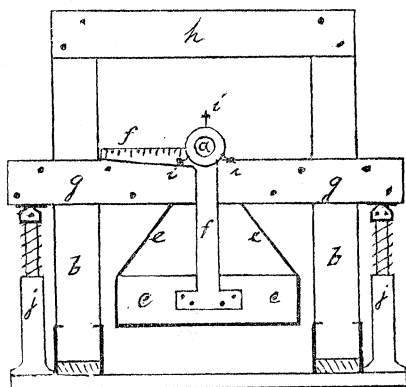


FIG. 1.

It is readily seen that the platform, when it was raised from the ground, as shown in fig. 1, was free to swing through a limited space, either to the right or left, and that any eccentric weight or force so applied as to tend to swing it to the left could be compensated by a weight upon the scale-beam, *ff*, which swings with it; so that the platform could be still kept in its horizontal position.

The axis about which the swinging tends to occur is the line of contact between *aa* and *gg*, which line we shall for brevity henceforth call the axis *aa*.

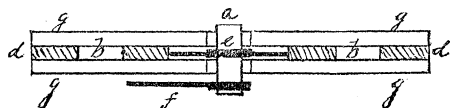


FIG. 2.

In setting up the dynamometer, it was so placed that the axis *aa* was directly below the axis of the driving-pulley, and in the same vertical plane with it. The dynamo to be tested was placed upon the platform *cc*, while *cc* was resting upon the ground; and it was blocked up on *cc* to such a height, that the axis of the armature was as nearly at the same height as the axis *aa* as could be readily done by direct measurement. This adjustment could be effected with all necessary exactness once for

all; for, even though the armature were slightly above or below the axis *aa*, no error would thereby be introduced into the observations.

The axis of the armature was also set, as nearly as it could be conveniently, in line with the axis *aa*; but the final adjustment, so that the centre of the armature-pulley was neither to the right nor left of the axis *aa*, was made mechanically as follows. The platform and dynamo were raised from the ground, and the girders *gg* carefully levelled by means of the jackscrews. The platform was then brought to a horizontal position by placing compensating weights upon it. The belt was next adjusted, and was tightened by lowering the platform. It was then found, that, in case the axis of the armature was to the right or left of *aa*, the tension of the belt exerted a force to tip the platform, and it no longer stood horizontal. This was corrected,—one half, by shifting compensating weights; and the other half, by moving the dynamo to the right or left. The belt was then slackened by raising the platform, and a similar adjustment again made to bring the platform to the horizontal position. This was repeated until the platform stood horizontal, whether the belt was tight or loose; both girders being at the same height, and both accurately levelled, account being taken of the bending.

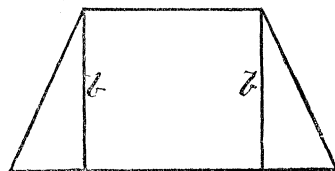


FIG. 3.

A further application of compensating weights was employed to render the balance sensitive. With the Edison dynamo, which is top-heavy (i.e., its centre of gravity is above the axis of the armature), more than a ton was hung on the sides of the platform to bring the centre of gravity of the whole down to the axis *aa*. With the other dynamos, whose centres of gravity are below the axis of their armatures, compensating weights of smaller amount were placed upon a staging built on the platform above the dynamos, in order to bring the centre of gravity of the whole up nearly to the axis *aa*.

In making the tests, the power was applied to turn the armatures clockwise in fig. 1. This caused the horizontal scale-beam *f* to rise; and weights were placed upon it to bring it back to the horizontal position. The moment of

the couple, got by multiplying the weight so applied by its distance from the axis *aa* as read upon the scale-beam, is evidently equal and opposite to the moment of the couple with which the armature is turned. Thus the moment of the force applied to run the armature was measured in foot-pounds. This moment, multiplied by the number of revolutions per minute and by 2π , is the work expended in driving the armature, in foot-pounds per minute.

It was found convenient to use a weight having a moment somewhat less than sufficient to bring the scale-beam to the horizontal, and employ a Chattrillon spring-balance with a dial-face reading to 2 oz. to furnish the remaining part of the couple. This balance was fastened to a vertical cord passing around a small winch, which enabled the observer to bring the scale-beam to the horizontal with facility.

The principal difficulty to be apprehended in testing with this dynamometer was a possible tendency to oscillation, which might be caused by running the belt. Had this existed, it might have been checked by a dash-pot; but the weight of the platform and dynamo was sufficient to almost entirely obviate any such difficulty, and give very considerable steadiness of position. Indeed, the jarring seemed to increase its sensitiveness, and evidently enabled the platform to come to rest in its position of equilibrium by overcoming any initial friction existing.

The structure was mostly built of three-inch plank, ten or twelve inches wide. The platform was designed to safely carry five tons at its centre.

For permission to make use of the cradle dynamometer, the jury is indebted to the kindness of Professor Brackett.

In addition to the use of the two dynamometers described, indicator-diagrams were taken from the steam-engine furnishing the power for driving the dynamo machines. Throughout the dynamometric tests the machines were driven by a Cummer engine of about a hundred horse-power, which furnished power for other dynamos than that upon the cradle, as well as for two or three pieces of machinery on exhibition in Power Hall. It was thus impossible to make the taking of indicator-diagrams contemporaneous with the regular tests, owing to the large load which the engine carried; and they were generally taken after ten o'clock at night, at which hour the remainder of the load was thrown off. Although these indicator-cards were not used in the final computations, they furnished valu-

able checks upon the performance of the dynamometers.

The electrical measurements.

For the purpose of making the electrical measurements as free from disturbance as possible, a small room, about twenty feet long and ten feet wide, was fitted up in the basement of the central part of the large exposition building. In this, three brick piers were built upon solid foundations, and two or three wooden brackets were firmly secured to the walls, so as to furnish firm resting-places for the galvanometers. The main lines of the arc-lighting systems were run through this room, and very heavy copper conductors connected the room with the space in which the dynamos were exhibited; so that the entire current from the incandescent machines could be introduced when desired.

The electric measurements consisted in the determination of the strength of the current, and the electromotive force between two points in the circuit. For this purpose several galvanometers of different kinds were employed. For the measurement of current strength the principal instrument used was one of Sir William Thomson's current galvanometers, made by White of Glasgow. Although of recent invention and construction, the instrument is probably so well known as not to require any detailed description. It consists essentially of a magnetometer, and a coil of very low resistance. In the magnetometer four short magnets are combined to form a needle, the position of which is indicated by a very light yet very rigid aluminum index. A steel magnet, bent in the shape of a semicircle, is placed in a vertical plane over the needle, so that the latter is approximately at the centre of the circle of which the magnet forms a part. One end of the magnet is furnished with a cross-piece of brass, from one extremity of which projects a pin which rests in a conical hole, and upon the other extremity is a 'button;' so that freedom of motion around the pin as an axis is allowed. The opposite end of the magnet rests in a groove cut around the end of a screw, by the movement of which the plane of the magnet can be shifted towards the east or towards the west.

The coil is fixed in a vertical plane at one end of a wooden table whose length is about one foot, and breadth about five inches. The table is furnished with levelling-screws, and a V-groove is cut lengthwise through the centre, at right angles to the plane of the coil. In

this groove the magnetometer, with its attached magnet, slides; so that, by placing the needle at different distances from the centre of the coil, the instrument may be used for measuring currents differing very greatly in strength.

The adjustment of the instrument consists in placing the magnetometer upon the table, without the field-magnet, and adjusting the whole so that the index is at zero of its scale; after which the magnet is put in its place, and, if necessary, one end is moved by means of the screw until the index again points to zero.

The interpretation of the reading of the instrument is a very simple operation. A scale along the edge of the V-groove shows the position of the magnetometer. It is necessary to know the strength of field at the needle, which is, of course, that due to the magnet, plus the horizontal component of the earth's magnetism; and then, if this strength of field in c.g.s. units be multiplied by the reading of the needle, and divided by the scale-reading of the magnetometer, the result will be the current in amperes.

This galvanometer was permanently mounted on one of the stone piers, and its connections were so arranged that it could be quickly thrown in or out of the circuit without interfering with the continuity of the same. The direction of the current through the galvanometer could be instantly reversed; and throughout the observations reversals were regularly made, so as to eliminate error arising from displacement of the zero. The zero-point was adjusted, however, at the beginning of every series of observations, and examined at frequent intervals during the same.

A differential galvanometer was also used in measuring current strength. This instrument was kindly loaned to the jury by Professor Brackett of Princeton, by whom it was devised and constructed. A description of it will be found in the *American journal of science*, vol. xxi. p. 395. It consists essentially of two heavy rings, one within the other, through which the current goes in opposite directions. The needle in the centre has a silk-fibre suspension. The radii of the rings being given, the constant of the instrument can be readily calculated. It was especially constructed for the measurement of strong currents, ten amperes giving a deflection of fourteen to fifteen degrees when the value of H is a little more than .2. When the current was steady, it behaved admirably; but with a fluctuating current it became extremely difficult to get trustworthy readings, owing to the constant vibration of the needle. The graduated circle was so small that

the estimation of fractions of a degree was quite uncertain. Even with steady currents, more time was required for reading the Brackett than the Thomson, owing to the length of time needed for the needle to come to rest after a reversal of current. For these reasons its use was not continued throughout the test. It was observed continuously during the tests of the Thomson-Houston dynamo, and during a part of the tests of the Weston dynamo, when, owing to fluctuation in the current, its use was necessarily discontinued. It served a useful purpose, however, as a check upon the indications of the Thomson instrument, the close agreement of the two justifying confidence in the indications of the latter. The most carefully made series of comparisons was that of Sept. 20. During the afternoon of that day, eight simultaneous readings of the two instruments were made; the current, which was remarkably steady, being furnished by the Thomson-Houston dynamo. The means gave 9.92 amperes as indicated by the Thomson, and 9.93 amperes for the Brackett. The regular tests were begun on Sept. 25, and in the mean time several additional conducting-wires had been brought into the testing-room. The indications of the Brackett galvanometer were, after this, constantly somewhat less than those of the Thomson, which was doubtless due to the alteration of the field by the presence of the currents. The difference was quite constant, and amounted to about two per cent. Thus, on Sept. 25 the Thomson gave 9.97 amperes, and the Brackett 9.77. On the 26th the Thomson indicated 10.0, and the Brackett 9.80, and on the 27th, with the Weston arc dynamo, showed 18.6 amperes, and the Brackett 18.3. That this discrepancy could be accounted for by the effect of the current upon the strength of field was established by vibrating a needle under two conditions, — with and without the currents. Herein is shown the advantage of a strong, permanent magnetic field, such as exists in the Thomson instrument. An alteration of the field, which might considerably influence the results from the Brackett, would hardly be perceptible with the Thomson.

During the tests of the arc-light machines the whole current was taken through the galvanometers. With the incandescent systems, however, in which the current was sometimes as high as 170 amperes, this was impossible; as the coils and connections would have been greatly heated. The current might possibly have been safely divided between four or five instruments; but, these not being at hand, it became necessary to make use of a shunt.

For this purpose the heavy main conductor was cut, and the two ends were inserted into large mercury-cups, cut out in a block of wood an inch and a half thick. These cups were also connected by about forty feet of number 0 copper wire, the ends of both main and shunt wire being well immersed in the mercury, and pressed close together. These mercury-cups were connected with two others by means of short copper wires, and into the second pair the ends of the galvanometer wires were plunged. As thus arranged, about one-fifth of the current was taken through the galvanometer. Even with this division of the current, it was found, that, when using the strong current from the Weston dynamo, the wires of the galvanometer were somewhat heated; and in order to avoid this result, a short piece of number 0 wire, not more than two or three inches in length, was bent so that it could be inserted in the mercury-cups, and thus cut the galvanometer out, except during the few moments necessary for taking a reading. During all of the 'resting' periods this short wire carried by far the greater portion of the current, and thus tended to prevent the heating of the shunt wire proper as well as of the galvanometer.

The determination of the ratio of the two parts into which the current was divided, or the value of the 'shunt multiplier,' was, of course, a matter of great importance. In the preliminary measurement of this ratio the current from the Thomson-Houston machine was of great service on account of its steadiness. To begin with, a number of tests were made to discover if the connection resistances were of such importance that any accidental variation in them would perceptibly alter the shunt ratio. The shunt was repeatedly lifted out of the cups and replaced, and the galvanometer connections were broken and remade. Every thing that could be disturbed was disturbed; but, upon reconstruction, the result was found in all cases to be practically unaltered. On Sept. 28 a series of twenty measurements was made with the shunt alternately in and out, using a current of 10 amperes. The results agreed closely with each other, and gave 4.6 as the value of the shunt multiplier. On the following day the tests of the incandescent machines began; and the shunt was not moved from its position, nor disturbed, until after the conclusion of the entire work. On Oct. 3, after all of the regular tests had been completed, another test of the shunt was made, with a current of 10 amperes, as before. Ten observations were made, all of which agreed in giving a ratio of a little more than 5.0. This result was quite

unexpected, and the discrepancy between it and that obtained from the first test was entirely too great to be accounted for by errors of observation. As circumstances prevented further tests in Cincinnati, it was determined to remove the shunt and all connections to the physical laboratory of the Ohio state university, where a thorough examination of the cause of the difference could be made. This was done; but, before any experimental examination had been undertaken, the origin of the difficulty suggested itself. The two short wires connecting the mercury-cups had been in one case thrown with the galvanometer doubtless, and in the other with the shunt. It was perfectly certain, however, that throughout the tests they had formed a part of the galvanometer. Upon examination, this explanation was at once found to be correct. The shunt and galvanometer were connected up precisely as they had been in Cincinnati: and a series of twenty-five observations gave, when the small wires were a part of the shunt, a multiplier of 4.60; and, when they formed a part of the galvanometer circuit, it was 5.01. The measurements were made by comparing the resistance of the two parts of the circuit by means of the fall in potential, as shown by a Thomson's reflecting galvanometer of high resistance. While in use in Cincinnati, the shunt was constantly carrying a portion of the current; and its temperature was therefore always slightly higher than that of the galvanometer. The difference was small, and it could not be measured accurately; but, on account of its existence, it was thought proper to adjust the shunt multiplier. An excess of heat in the shunt would throw a greater amount of the current through the galvanometer than would go there if the two were at the same temperature: accordingly, the value accepted was 4.9 instead of 5.0, as indicated by the comparison, in which the currents used were much weaker than those transmitted during the tests. It will be observed, the existence of an excess of temperature in the shunt favors somewhat the system in which the stronger current was transmitted.

In the measurements of electromotive force, Thomson's potential galvanometer, by White, was used. In the beginning a large number of comparison observations were made, in which the same electromotive force was measured by this instrument and by the well-known method of discharging a condenser through a high-resistance galvanometer.

A condenser of one-half micro-farad capacity, and a reflecting galvanometer of nearly seven thousand ohms resistance, both by Elliot Broth-

ers, were used with a battery of ten Daniell cells in good condition. These comparisons proved that the indications of the potential galvanometer could be relied upon as trustworthy within practical limits, and in the actual tests it alone was used on account of the greater convenience and rapidity with which observations could be made. Further tests of its accuracy were made, however, which will be referred to later. It is sufficient to say, that this instrument, in form and construction, is quite similar to the current galvanometer already described, except that the coil has a resistance of nearly seven thousand ohms. A key is placed in the circuit, so that the current passes through the coil only during the few moments necessary to secure a reading, thus preventing the heating of the coil. The difference of potential in volts, between the two points to which the leading wires are connected, is found by the same process as is used for reducing the readings of the current galvanometer to amperes. In measuring the efficiency of the dynamos, wires were brought from their binding-posts to the galvanometer. In the arc-light machines the electromotive force was high, amounting to more than twelve hundred volts in the Thomson-Houston dynamo; and it was therefore desirable to introduce extra resistance in the galvanometer circuit. From resistance-boxes made by Elliot Brothers, an amount equal to seventeen times the resistance of the galvanometer was thrown in, thus bringing the fall in potential in the galvanometer within easy range. Great care was taken to see that the coils were not heated during these measurements; and for this purpose the boxes were opened, and the coils exposed to the air, frequent examination being made to see that no rise in temperature took place. Precisely the same arrangement existed throughout the tests of both arc systems. During the photometric tests the wires of the potential galvanometer were attached directly to the lamp under test, so that the fall in potential through the lamp only was measured.

Photometric measurements.

Unquestionably, the most difficult question to deal with, in work of this kind, is the question of photometry. The expression of illuminating-power in 'candles' is a matter of great uncertainty, arising from the uncertain character of the standard, and also from the great inequality existing in the intensity and composition of the lights which are brought into comparison. As the test was intended to be

purely competitive, the jury decided to ignore the question of 'candle-power' entirely, and confine itself to a comparison of the lights under consideration. It is believed that the adoption of this plan rendered the results free from many errors to which they would otherwise have been liable.

The photometric comparisons were made by means of the ordinary Bunsen disk photometer, as modified by Letheby. Some preliminary experiments were made with one of Glan's spectrum photometers, for the use of which the jury was again indebted to the kindness of Professor Brackett. The adjustments of this instrument are delicate, and observations cannot be made so rapidly with it as with the ordinary disk photometer; so that, in consideration of the limited time at the disposal of the jury, it was decided not to attempt its general use throughout the tests. It was hoped and intended, in the beginning, to make a thorough examination of the composition of the different lights; but unforeseen delays in the preparation of other portions of the machinery of the test forbade this. As the candle was not made use of, all the lights which were compared were more nearly of the same composition, and thus much of the difficulty in the use of the disk photometer did not appear.

It was found most convenient to make the comparison of the arc-lights through one of the incandescent lamps, as the steadiness and constancy of these could be depended upon during the time necessary for a comparison. In these measurements, a long gallery in the basement of the main building, and adjoining the testing-room, made it possible to place the two lights which were being compared at a distance of fifty feet from each other. The line extended into the testing-room, where the photometer-bar, ten feet in length, was placed. An Edison incandescent lamp, nominally of sixteen candle-power, was used as a standard. In the first series of experiments, comparisons were made with the arc-lamps in three different positions; five readings of the position of the photometer-box and of the galvanometers being made at each position. The lamp was first suspended in its normal, vertical position; then afterwards it was inclined at an angle of forty-five degrees, first with its base away from the photometer-box, and afterwards with its base towards the same. After such a series had been completed with one of the two lamps in competition, it was at once removed, and its place was supplied by the other. On the following night the comparison was continued, other lamps having been selected; but the lamps were tested in only two

positions,—the normal position, and that in which the base of the lamp was towards the photometer-box; these being regarded as the positions of the greatest importance. Altogether, twenty-five photometric observations were made in comparing the arc-lamps. The lamps compared were taken at random from those in use by the exhibitors.

The comparison of incandescent lamps presents questions of far greater delicacy and difficulty. There is one element, in the economy of an incandescent lamp, which does not enter to any extent in the consideration of arc-lamps; that is, the life of the lamp. Although of great importance, it did not seem possible, in the limited time which was at the disposal of the jury, to investigate this point. The only fair and impartial method of making such an investigation, involved, in the opinion of the jury, the continuous and prolonged burning of a large number of lamps belonging to the different competing systems. Under the circumstances, it was absolutely impossible to make use of this method.

There exists, also, difference of opinion as to the proper method of comparing the efficiency of two incandescent lamps. They may be reduced to the same illuminating-power, and the electrical energy consumed by each may be compared; they may be brought to a condition in which they consume the same electrical energy, and their illuminating-power compared; or they may be allowed to differ in both of these elements, and comparisons be made in both.

The first method has been pursued in several tests which have been made both in Europe and in this country.

Incandescent lamps are generally made to be equal, nominally, to a given number of standard candles; but, by modifying the consumption of energy, a lamp of nominally low candle-power can be made to produce almost any degree of illumination, from nothing up to the equivalent of several hundred candles, the high illumination being, of course, at the expense of the life of the lamp. If this element is left out of consideration, the efficiency of a lamp increases rapidly with its degree of incandescence. As it is by no means necessary that incandescent lamps should run at a fixed 'candle-power,' it will follow that the temperature at which a lamp will show greatest efficiency (including the life element) will depend greatly upon its construction.

Taking two lamps of radically different construction, however, there will be for each a certain set of conditions as to current strength and electromotive force, and including the

element of life, under which it would show its highest efficiency and economy. After such conditions were determined for each lamp, a strict comparison would be possible. The reduction of two such lamps to the same degree of illumination would probably be unfair to one or the other, or possibly to both, if the element of life is not considered.

Suppose that a lamp in one system is at its best, *all things considered*, at fifteen candle-power, and that one in another reaches its highest degree of efficiency at sixteen candle-power. If they are both brought to fifteen candle-power, the second must suffer in the comparison; and if both are brought to sixteen candle-power, *and the element of life is not considered*, it will again suffer, for the apparent efficiency of the first will be increased by its higher incandescence.

As the labor of determining the most favorable conditions for each lamp would be so great as to necessarily throw that method out of consideration, the jury felt constrained to adopt the last of the three methods mentioned above. The jury assumed, in fact, that the exhibitors of the different systems had already determined these favorable conditions in their own interest; and that in putting their lamps before the public for the entire period of the exposition, each maintaining more than two hundred lamps in different parts of the exposition building, they would operate them as nearly as possible in accordance therewith. In other words, it was decided to compare the lamps as they were used in the exhibit, determining the ratio of their illuminating-power, and measuring the electrical energy consumed by each. It is proper to state, that the lamps of both systems were spoken of by their respective representatives as sixteen candle-power lamps, although certain marks on the lamps which were supposed by the jury to refer to candle-power did not exactly agree.

To secure impartiality of selection, the jury requested permission to have access to the supply of lamps kept by each company for use in the exhibit, which permission was freely granted. From each, ten or twelve were selected at random, and carried to the testing-room; and from these the lamps which were compared were taken. They were placed upon the photometer-bar at a distance of a hundred and twenty-five inches from each other, and a system of switches was arranged, so that the galvanometers could be quickly connected with one or the other. Measures of current and electromotive force were made

rapidly and continuously during the photometric comparison.

Neither of the two lamps under test illuminated equally in all directions. They were therefore compared in nine different positions, each lamp assuming three, which were designated respectively, 'flat,' 'edgewise,' and 'forty-five degrees;' and each position of one was compared with all of the other. Five sets of readings were made at each position, making, in all, forty-five comparisons of the two lamps. A number of preliminary comparisons were made, which were not considered as forming a part of the actual test. The latter was made on the evening of Sept. 29.

The determination of the efficiency of the dynamos consisted in measuring the power consumed, as shown by the dynamometer, on the cradle of which the dynamo was placed, and at the same time measuring the current and the electromotive force at the binding-posts of the machine. The speed of the main shaft being nearly uniform, it was necessary to place different pulleys upon it, in order to secure the necessary speed for the armatures of the different machines. The speed of running being a matter which concerned the exhibitors rather than the jury, they were requested to furnish the dimensions of these pulleys, and accordingly did so. The average speed of the armature of the Weston dynamo for incandescent lamps was a little above ten hundred and thirty revolutions per minute, during three different series of observations made while the machine was on the cradle. The Edison dynamo was placed on the cradle on the afternoon of Oct. 2, when a series of measurements was made with an average speed of ten hundred and sixty-eight revolutions. This was above what may be called the 'normal speed,' which was due partly to the size of the pulley, and partly to the fact that the engine was doing but little other work, and was probably running a little above its normal rate. In the evening the tests were continued, the speed of the armature being a little below a thousand revolutions, the electromotive force being also less. It will be observed that the 'efficiency' of this dynamo, under the latter conditions, differs from that under the former by only two-tenths of one per cent. Particular attention is called to the fact, that no photometric measurements were made with lamps on the circuit of the Edison machine, which was on the dynamometer; those used being supplied from another similar dynamo, which was run by an Armington and Sims engine, which formed a part of

the Edison exhibit. A glance at the results given below will show that the electromotive force in the latter case was much lower than in the former.

Tests of the galvanometers.

Although the jury was satisfied of the accuracy of the Thomson galvanometers, within all practical limits, before deciding to rely upon their indications, for reasons that need not be referred to here, it was considered desirable, after the conclusion of the tests, to make such an examination of them as would leave no doubt as to the correctness of this opinion. The chief cause of error in these instruments, and in all of a similar construction, is the possible variation in the strength of the permanent magnets which establish the field in which the needles move. The existence of a strong field is a great advantage, as has already been pointed out, provided its value is known. An examination of the instruments was made before they were taken to Cincinnati; and then, again, when they were mounted in the testing-room, they were compared with others not liable to such alterations, as before related. Numerous tests were made to ascertain if each instrument was consistent with itself by measuring the same quantity with the magnetometer at different points of its scale, thus varying the position of the needle; and the results were satisfactory. Finally, after the instruments were returned to the physical laboratory of the Ohio state university, they were subjected to tests, a brief account of which is as follows:—

For the potential galvanometer, ten cells of the 'gravity battery,'—the elements of which were zinc, zinc sulphate, copper sulphate, and copper,—in good condition, were individually compared by the condenser method with a standard Daniell cell set up for the purpose. They differed very little among themselves; and when the electromotive force of the ten, in series, was measured by means of the Thomson instrument, the resulting electromotive force of the Daniell was 1.106 volts. The instrument was also compared with one of Ayrton and Perry's voltmeters, kindly furnished for the purpose by the Electric supply company of New-York City. For this purpose recourse was had to an Edison lighting-plant, the instruments being applied to the same lamp. The fall in potential in the lamp was at first 110 volts, which was beyond the range of the Ayrton and Perry instrument; but it was reduced a little below 100 volts, and two measurements were taken with each instrument.

The Thomson read the same in both measurements, making the electromotive force 97.6 volts. The divisions on the scale of the Ayrton and Perry were very small, making the reading quite difficult. From it were obtained, in the two measurements, 96.1 and 95.5 volts.

Assuming that the field of the potential galvanometer is known, it is easy to determine that of the current galvanometer, as the magnets are interchangeable. A series of observations was made in which a practically constant quantity was measured, first with one of these magnets on the magnetometer, and then with the other, alternating throughout the series. Twelve observations made in this way show a mean difference of 1.75% between the two magnetic fields. In the numbers used in these tests the difference is 2%.

The current galvanometer was also compared with an Ayrton and Perry ammeter at the same time at which the potential instruments were compared. The circumstances did not allow the use of a stronger current than that passing through a single Edison lamp. The result was therefore not of great value. The Thomson showed 1.05 ampères, and the Ayrton and Perry gave 1.03 for the same current.

Several tests of the current galvanometer were made by means of a battery of five Grove cells, which were freshly set up. The reading of the galvanometer was noted, and then a resistance of one ohm was introduced into the circuit. The first reading was 19, and the second was 9.5; showing that the resistance of the battery and galvanometer was one ohm. The electromotive force of the battery was then determined by means of the potential galvanometer. Two measurements were made; the first giving 9.43 volts, and the second 9.56 volts. Assuming the resistance to be one ohm, as shown above, these numbers would represent, in accordance with Ohm's law, the current in ampères. The current, as calculated from the galvanometer reading, was 9.5 ampères.

Many other tests of a similar character were made, all of which showed that the galvanome-

ters must be admitted to be what they were assumed to be during the tests, — practically correct. But, even if they were somewhat in error, the similarity of conditions under which the competing systems were tested was such that all would be affected alike.

Results.

In determining the efficiency of the dynamos, after every thing was found to be in good order, a run of about half an hour was made; during which time readings were taken every two minutes, as nearly as could be, of the dynamometers and electrical instruments. Generally from ten to twenty sets of readings were secured. In most cases two or more 'runs' were made; the repetition being in some instances the desire of the jury, and in others of the exhibitors. Sometimes the conditions under which the dynamo was running were changed by the exhibitors, with the expectation, doubtless, of increasing its efficiency thereby. In the following summary of results, the numbers showing the electromotive force, current strength, power consumed, etc., are means of a number of observations.

Photometry of arc-lamps.

The table on the next page shows the results of the photometric comparison of the two arc-lamps, and will be easily understood. The arrows show the direction of the light measured in each series: thus, $\leftarrow$ means a horizontal measurement; $\nwarrow$ means that the measurement was of the light going upward at an angle of forty-five degrees; and $\swarrow$ refers to the light going downward at an angle of forty-five degrees. For convenience, the intensity in terms of the standard (an Edison incandescent lamp) is multiplied by 1,000 before dividing by the number of Watts.

It will be seen that the different lamps differed from each other considerably in their efficiency. This was especially true of the Weston lamp, which was irregular in its ac-

Efficiency of dynamos.

	Thomson-Houston dynamo for arc lighting.		Weston dynamo for arc lighting.	Weston dynamo for incandescent lighting.			Edison dynamo for incandescent lighting.	
	Sept. 25.	Sept. 26.	Sept. 28.	Sept. 29.			Oct. 2.	
Electromotive force, in volts . .	1232.0	1175.0	626.0	69.2	60.0	65.0	124.9	122.8
Current in ampères	10.03	10.08	20.3	168.1	145.7	157.4	124.7	119.3
Electrical horse-power	16.6	15.9	17.0	15.6	11.7	13.7	20.9	19.6
Horse-power consumed	19.32	20.59	19.75	18.55	12.8	15.5	21.96	20.64
Percentage of efficiency	85.9	77.2	86.5	84.1	91.4	88.4	95.2	95.0

Arc-lamps.

THOMSON-HOUSTON.						WESTON.					
Direction of light.	Current.	Electro-motive force.	Watts.	Intensity in terms of standard.	$\frac{1000 I}{W}$	Direction of light.	Current.	Electro-motive force.	Watts.	Intensity in terms of standard.	$\frac{1000 I}{W}$
↑	10.2	45.9	467	16.2	34.7	↑	20.7	23.9	495	25.9	52.4
↗	10.2	46.7	475	13.2	27.8	↗	20.1	23.3	469	17.6	37.4
↘	10.2	46.3	471	85.0	180.3	↘	19.3	21.9	435	32.3	74.4
<i>Other lamps.</i>											
↑	10.1	46.1	465	18.0	38.8	↑	20.0	25.6	512	30.7	59.9
↘	10.2	46.3	474	98.8	209.0	↘	20.8	25.0	522	51.7	99.2
<i>Means.</i>											
↑	-	-	-	17.1	36.7	↑	-	-	-	28.3	56.1
↗	-	-	-	13.2	27.8	↗	-	-	-	17.6	37.4
↘	-	-	-	91.9	194.6	↘	-	-	-	42.0	86.8
<i>General means.</i>											
	-	-	-	40.7	86.4		-	-	-	29.3	60.1

tion. The numbers under the head of 'General means' show the average light in terms of the standard, in all directions measured, and the relative illuminating-power per unit of energy. There is a difference of more than forty per cent in favor of the Thomson-Houston.

Photometry of incandescent lamps.

The table below, showing the results of the photometric comparison of the incandescent lamps, will need but little explanation. In the first column the relative position of the carbon filaments is shown: thus, | | means that they were parallel to each other, and at right angles to the photometer-bar. The three positions of

a lamp were designated as 'flat' (|), 'edge-wise' (—), and 'forty-five degrees' (↘ or ↗).

$\frac{W_E}{W_M}$ denotes the Watts of the Edison divided by the Watts of the Maxim. The column headed $\frac{E}{M}$ shows the actual illuminating-power of the Edison, compared with the Maxim as a unit; and the numbers are the squares of the ratios of their respective distances from the photometer-box. The numbers in this column, divided by those in the one preceding, give the numbers in the last column, headed $\frac{E_E}{M_E}$, or the

Incandescent lamps.

POSITION.		EDISON.			MAXIM.			$\frac{W_E}{W_M}$	$\frac{E}{M}$	$\frac{E_E}{M_E}$
Edison.	Maxim.	Current.	Electrom. force.	Watts.	Current.	Electrom. force.	Watts.			
		.648	113.0	73.2	.887	63.7	56.5	1.30	1.11	.855
↗		.639	114.7	72.5	.887	64.5	57.2	1.26	1.13	.891
—		.636	114.6	72.9	.870	61.8	53.7	1.36	1.28	.941
—	↘	.622	115.4	71.8	.853	62.2	53.0	1.35	1.65	1.22
—	—	.631	115.4	72.8	.853	61.4	52.3	1.39	4.58	3.29
↗	—	.631	116.1	73.3	.887	63.0	55.8	1.31	3.96	3.02
	—	.631	115.7	73.0	.870	62.6	54.4	1.34	3.74	2.79
	↘	.639	116.5	74.5	.887	63.0	55.8	1.33	1.35	1.02
↗	↘	.648	114.7	73.5	.853	62.6	53.4	1.38	1.66	1.21

light from the Edison per unit of energy as compared with the Maxim.

The results of these comparisons in nine different positions make it possible to establish certain comparison equations, from which means may be obtained which will serve to eliminate, to some extent, the errors of experiment.

Let a = the light from the Maxim lamp 'edgewise;' then, by working through the different positions of the Edison, the above results give—

$$\text{Maxim} \left\{ \begin{array}{l} \nearrow \\ \downarrow \end{array} \right. \begin{array}{l} a \\ 2.77a \\ 3.58a \end{array} \quad \begin{array}{l} a \\ 2.39a \\ 3.50a \end{array} \quad \begin{array}{l} a \\ 2.77a \\ 3.37a \end{array}$$

and for means —

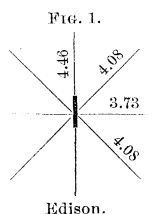
$$\text{Maxim} \left\{ \begin{array}{l} \nearrow \\ \downarrow \end{array} \right. \begin{array}{l} a \\ 2.64a \\ 3.48a \end{array}$$

By a similar computation it is found that—

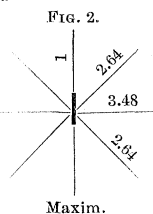
$$\text{Edison} \left\{ \begin{array}{l} \nearrow \\ \downarrow \end{array} \right. \begin{array}{l} 4.58a \\ 3.96a \\ 3.74a \end{array} \quad \begin{array}{l} 4.45a \\ 3.93a \\ 3.58a \end{array} \quad \begin{array}{l} 4.36a \\ 4.38a \\ 3.86a \end{array}$$

the means of which give —

$$\text{Edison} \left\{ \begin{array}{l} \nearrow \\ \downarrow \end{array} \right. \begin{array}{l} 4.46a \\ 4.08a \\ 3.73a \end{array}$$



Edison.



Maxim.

Figs. 1 and 2 show the arrangement of these intensities of illumination around the carbon filament; the plane of the filament being vertical, and Maxim edgewise being taken as unity.

For the mean all round, the result is —

$$\begin{array}{l} \text{Edison} = 4.09 \quad \text{Maxim} = 2.44 \\ \frac{4.09}{2.44} = 1.676 = \frac{E}{M} \text{ in light.} \end{array}$$

But from the previous table,

$$1.336 = \frac{E}{M} \text{ in energy :}$$

therefore $\frac{1.676}{1.336} = 1.25 = \frac{E}{M}$ in light per electrical horse-power.

It seems evident that this difference of twenty-five per cent in favor of the Edison lamp is largely due to the form of the incandescent filament as compared with that of the Maxim lamp. The latter shows great inequality in illumination in different directions, the light measured from the flat side being about three and one-half times as great as that ob-

tained when the lamp is edgewise. The effect of this increased radiating surface is shown in the last column of the above table, from which it appears, that in the comparison of the Maxim, 'flat,' with the Edison in all positions, the former shows a higher actual efficiency than the latter. If this large radiating surface could be made to distribute its effect around the circumference, the lamp would, in the opinion of many, be greatly improved. It is fair to say, however, that the unequal distribution of light is claimed, by at least some of the representatives of this lamp, to be an important advantage. It was not so considered by the jury.

The form of the carbon filament in the Edison lamp is such that a much greater uniformity of illumination results. While the Maxim form has the advantage of concentrating the radiating surface, the arrangement of the carbon to accomplish this greatly diminishes its effectiveness in the 'edgewise' position. In the Edison there is but a single loop; and, furthermore, this is generally curved, so that it does not lie in one plane. As a result, one side of the loop never exactly hides the other, and there is but little loss from that source. It will be seen in the above figure that the illuminating-power of the lamp edgewise actually exceeded that in any other direction. This difference was too constant and too great to be attributed to error in experiment. It is attributable, no doubt, to the fact, that in this position the luminous lines lie nearly in the axis of the pear-shaped glass containing them, as viewed from the photometer-box; there being, therefore, less scattering of the light in transmission, and possibly some gain on account of reflection. Of course, if a lamp were used in which one of the branches of the loop exactly or nearly covered the other in this position, a different ratio of illumination might follow.

Throughout the entire series of tests the jury was fortunate in having the assistance of Mr. A. L. Rohrer, a student in physics in the Ohio state university.

In the distribution of work, Mr. Eddy and Mr. Laidlaw made the observations, and kept the records of the dynamometer work; Mr. Laidlaw also taking and reducing the indicator-cards. Mr. French made the readings of the position of the photometer-box, and set the same. Mr. Mendenhall generally read one of the galvanometers, and Mr. Rohrer the other; the latter generally keeping the notes of the electrical work, although this was done on several occasions by Mr. French and by Mr. Laidlaw.

The results of these tests seem to point to one conclusion of very considerable interest. It happened that the competition in both the arc and incandescent systems was between low electromotive force and great strength of current, on the one hand, and high electromotive force, with weaker current, on the other. In one arc system the electromotive force was almost exactly double, and the current almost exactly half, that of the other. In the incandescent systems, the contrast, although not so great, was very marked. In these trials the advantage was decidedly on the side of high electromotive force.

*NOTES ON THE VOLCANIC ERUPTION
OF MOUNT ST. AUGUSTIN, ALASKA,
OCT. 6, 1883.¹*

On the western side of the entrance to Cook's Inlet (forty-five miles wide) lies Cape Douglas; and to the northward of the cape the shore recedes over twenty miles, forming the Bay of Kamishak. In the northern part of this bay lies the Island of Chernaboura ('black-brown'), otherwise called Augustin Island. It is eight or nine miles in diameter, and near its north-eastern part rises to a peak called by Cook, Mount St. Augustin. As laid down by Tebenkoff, the island is nearly round. The northern shores are high, rocky, and forbidding, and are bordered by vast numbers of rocks and hidden dangers. The southern shore is comparatively low.

Mount St. Augustin was discovered and named by Capt. Cook, May 26, 1778; and he describes it as having 'a conical figure, and of very considerable height.' In 1794 Puget describes it as

"A very remarkable mountain, rising with a uniform ascent from the shores to its lofty summit, which is nearly perpendicular to the centre of the island, inclining somewhat to its eastern side. . . . Towards the seaside it is very low, from whence it rises, though regular, with a rather steep ascent, and forms a lofty, uniform, and conical mountain, presenting nearly the same appearance from every point of view, and clothed with snow and ice, through which neither tree nor shrub were seen to protrude; so that, if it did produce any, they must either have been very small, or the snow must have been sufficiently deep to have concealed them."

At that time there were native hunters, under the direction of two Russians, hunting or living in the vicinity of the north-eastern point of the island.

Vancouver placed the peak of this mountain

in latitude $59^{\circ} 22'$: Tebenkoff places it in latitude $59^{\circ} 24'$.

The peak of St. Augustin is distant forty-nine miles nearly due west (true) from the settlement on the southern point of Port Graham, or, as it is sometimes called, English Harbor. This harbor is situated on the eastern side of Cook's Inlet, near Cape Elizabeth.

In connection with the fall of pumice-dust at Iliuliuk on Oct. 16, 1883, it may be of interest to observe, that the peak of Augustin is over seven hundred miles to the north-eastward of Bogosloff Island, off Unalashka (see map).

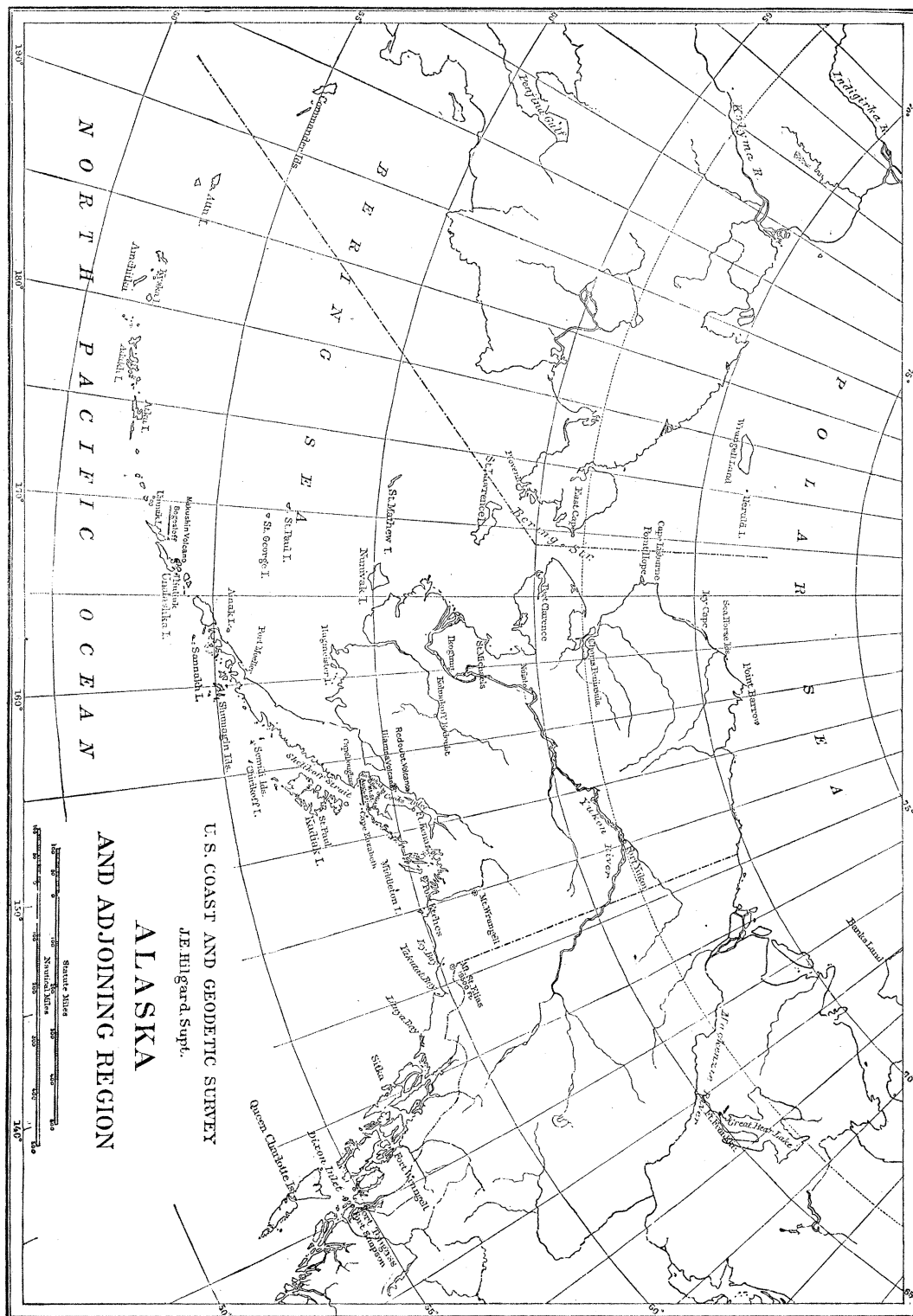
About eight o'clock on the morning of Oct. 6, 1883, the weather being beautifully clear, the wind light from the south-westward (compass), and the tide at dead low water, the settlers and fishing-parties at English Harbor heard a heavy report to windward (Augustin bearing south-west by west three-fourths west by compass). So clear was the atmosphere that the opposite or north-western coast of the inlet was in clear view at a distance of more than sixty miles.

When the heavy explosion was heard, vast and dense volumes of smoke were seen rolling out of the summit of St. Augustin, and moving to the north-eastward (or up the inlet) under the influence of the lower stratum of wind; and, at the same time (according to the statements of a hunting-party of natives in Kamishak Bay), a column of white vapor arose from the sea near the island, slowly ascending, and gradually blending with the clouds. The sea was also greatly agitated and boiling, making it impossible for boats to land upon or to leave the island.

From English Harbor (Port Graham) it was noticed that the columns of smoke, as they gradually rose, spread over the visible heavens, and obscured the sky, doubtless under the influence of a higher current (probably north or north-east). Fine pumice-dust soon began to fall, but gently, some of it being very fine, and some very soft, without grit.

At about twenty-five minutes past eight A.M., or twenty-five minutes after the great eruption, a great 'earthquake wave,' estimated as from twenty-five to thirty feet high, came upon Port Graham like a wall of water. It carried off all the fishing-boats from the point, and deluged the houses. This was followed, at intervals of about five minutes, by two other large waves, estimated at eighteen and fifteen feet; and during the day several large and irregular waves came into the harbor. The first wave took all the boats into the harbor, the receding wave swept them back again to the inlet,

¹ Communicated by Prof. J. E. Hilgard, superintendent U. S. coast and geodetic survey.



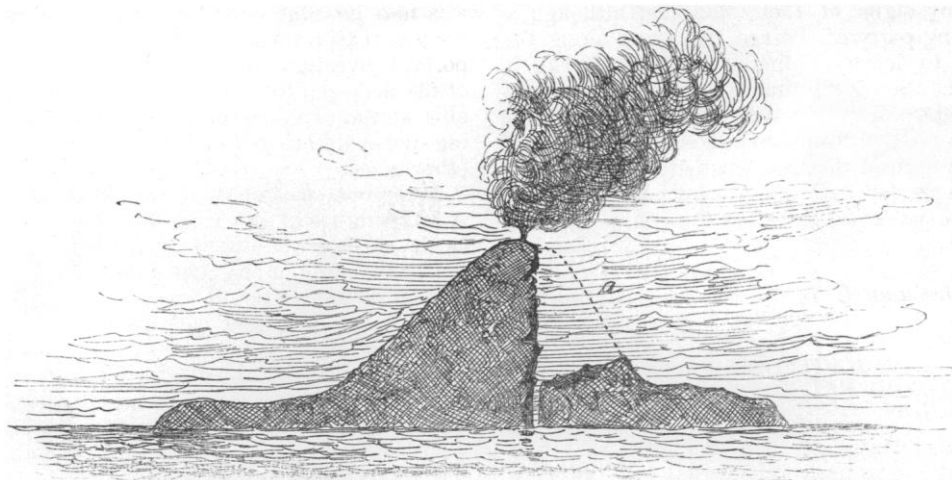
and they were finally stranded. Fortunately it was low water, or all of the people at the settlement must inevitably have been lost. The tides rise and fall about fourteen feet.

These earthquake waves were felt at Kodiak, and are doubtless recorded on the register of the coast-survey tide-gauge at that place. Also the pumice-ashes fell to the depth of four or five inches, and a specimen of the deposit was given to the tidal observer at St. Paul. It will be interesting to compare these ashes with those collected at Iliuliuk on the 16th of October, and which, from a confusion of dates, were supposed to have come from the new Bogosloff volcanic island. I am of the opinion that they came from St. Augustin.

The condition of the Island of Augustin or

distinct accounts of its eruption and subsequent appearance; but Capt. C. T. Sands, who was at English Harbor, gave the Alaska company a full description; and Capt. Cullie of the Kodiak states, that, if there were plenty of water in the line of rupture, it would be possible for a vessel to sail through (see figure). At the time of Capt. Sands's observations the low ground of the island was visible, and seemed to be a vast crater, from which smoke and flames were issuing.

But beyond all these phenomena, apart from the volcanic eruption and the rupture of the island, we have the report of Capt. Cullie of the schooner Kodiak (from whom we also obtain a statement in regard to the rupture), who approached the island from English Harbor on



MOUNT ST. AUGUSTIN AFTER THE ERUPTION, AS SEEN BY CAPT. CULLIE, NOV. 10, 1883. *a*, THE ORIGINAL OUTLINE.

Chernaboura, according to the latest accounts, is this:—

At night, from a distance of fifty or sixty miles, flames can be seen issuing from the summit of the volcano; and in the day-time vast volumes of smoke roll from it. Upon nearer approach from English Harbor, it was found that the mountain had been split in two from peak to base by a great rupture extending across it from east to west, and that the northern slope of the mountain had sunk away to the level of the northern cliff.¹ This is corroborated by the statement of the hunting-party in Kamishak Bay. Smoke issued from the peak at a very short distance to the southward of the rupture.

The party of natives on Kamishak did not approach the islet, though they gave clear and

¹ Capt. Cullie's account.

the 10th of November, and found that a new island, about a mile and a half long and seventy-five feet high, had been upheaved in the ten-fathom passage between Augustin and the mainland to the westward. This passage is from six to eight miles wide, and was sailed through by Puget in Vancouver's voyages of discovery.

This new island (also reported by the hunting-party in Kamishak) would appear to have arisen during the late volcanic activity. It lies to the north-westward of Chernaboura Island (Augustin), and was distinctly seen from the Kodiak, as that vessel lay ten miles to the north-eastward, and had clear weather.

To show the violence of the volcanic convulsions at this time, two extinct volcanoes on the Alaska peninsula, which are reported to be about west (true) from the active volcano Iliamna (twelve thousand feet high), had burst

into activity; and during the day volumes of smoke were distinctly seen, and columns of flame at night. Usually, at that season, Augustin and the peak are covered with deep snow. On the 10th of November, however, when Capt. Cullie approached the island, while there was a depth of four feet of snow at Port Graham (English Harbor), Mount St. Augustin was bare and black.

During this same season, a party of seven or eight Aleuts had established themselves on Chernaboura (Augustin) Island to hunt the otter during the winter. Two of the women refused to remain on account of the violent noises inside Mount St. Augustin; and they were taken to St. Paul, Kadiak. Since the eruption no one of this party has been seen, nor any signs of their bidarkas, although a rescuing party of natives had gone along the coast to learn of their whereabouts. It is feared, therefore, that they have been destroyed. In confirmation of this report of the native women, Capt. Sands says that he and others noticed that St. Augustin was emitting smoke as far back as August; but no other signs were observed before the heavy report of Oct. 6.

GEORGE DAVIDSON,
Assistant U. S. coast and geodetic survey.

THE COD-HATCHING EXPERIMENTS AT GLOUCESTER BY THE FISH COM- MISSION.

IN the winter of 1878 and 1879 the Fish-commission at that time having a station at Gloucester, Mass., made very extensive experiments upon the hatching of certain salt-water fish, but more especially of the cod (*Gadus morrhua*). For years the cod has been almost entirely confined to the deeper waters on the coast, having been driven there by many causes, sewerage being the most probable and potent; and it has been since the discovery of America that these fish, at that time extremely abundant everywhere along the shore, even to such an extent that they could be caught in great numbers from any point of rocks, have become reduced in numbers to their present comparative scarceness, and at the same time driven from their former haunts to the deeper waters. Taking into account this remarkable decrease in numbers, and change of habitat, Professor Baird conceived the idea that the former abundance of cod could in part be restored by means of artificial propagation, which had proved so successful with the fresh-water species of fish. Many difficulties stood

in the way, — difficulties which had never been encountered in any previous experiments. The principal trouble which was experienced resulted from the floating of the eggs, and it was only after many trials and numerous failures that an apparatus was invented which in part prevented the eggs from clogging the screen placed over the overflow-pipe.

The location for the primary experiments was fixed at Gloucester, on account of the great industry of catching and preparing these fish, which is centred there. Vessels and boats arrive every day during the winter months, bringing in fresh cod, many of them containing spawn. By the request of the commissioner, such fish were kept alive until they could be put into the live-box at the hatchery. It was also possible, and this was the most important reason for the choice, to carry on important investigations into the natural history of the deep-sea food-fishes, and to gather valuable statistics concerning the fisheries; it being impossible to get such information in any other place.

Many obstacles arose, owing to the location. A temperature of 30° F. is fatal to cod; and, as the surface-water in the harbor is liable to reach this point at any time during two or three months of the winter, it was necessary that the car containing the live fish from which spawn was to be taken should be constantly watched, and sunk to the bottom during every cold snap. The filthiness of the water caused by decaying waste portions of fish thrown into the docks — these being common receptacles for all dirt and refuse formed by the dressing-process — was such, that, even after the most careful filtering, the water was in a decidedly impure condition. The north-east storms so prevalent on the Massachusetts coast, especially during winter, kept the water in a roiled condition for a greater part of the time; so that when it reached the aquaria, although a great part of the mud had been filtered out, still the mudiness was apparent. Such a condition could not be other than an unhealthy one for young fish whose parents had been accustomed to the clear, cool, outer waters. When there were no storms, the great rise and fall of tide, about eleven feet, sufficed to keep the finer mud in constant circulation. But, notwithstanding these numerous obstacles, over one million and a half young cod were successfully hatched, and placed in the clearer waters of the outer harbor at Gloucester. On account of the impurity of the water even there, and the adverse conditions under which they were hatched, it was scarcely expected that any

practical increase in the number of cod would be noticed as the result of these experiments. However, the results obtained proved conclusively, that if carried on under favorable circumstances, and with the experience gained at Gloucester, hatching deep-sea fish could be successfully engaged in, and made a great success. It was with this belief that an appropriation was obtained from Congress for building the extensive hatching houses and basins which are in progress of erection at Wood's Holl, Mass. Here the harbor is very pure, there being no city emptying its refuse into the immediate waters. The bottom is composed of clean sand; while the water is pure and not too cold, receiving an offshoot of the Gulf Stream, instead of the Labrador current, as is the case at Gloucester. Here the tides, although forming swift currents by the pouring of immense quantities of water through narrow outlets, rise but two feet, which is a decided advantage. Within forty miles of the hatchery, fish can be caught in sufficient abundance to supply the wants of the commission; and it is to be expected that results of great importance will be obtained by hatching and placing young food-fish in the water at various points along the New-England coast.

For at least a year, reports have been prevalent to the effect that small cod belonging to the deep-sea species have been, and are at present, very abundant in the harbor at Gloucester. In order to find out definitely, Professor Baird asked me to inquire, and collect specimens if possible, while I was at Gloucester, in October. I ascertained, that, since the winter of 1882, 'silver-gray cod' (*G. morrhua*) have been caught in abundance, and of just the size that the artificially hatched fish would naturally be at this time. Not only are cod obtained in the outer harbor by the fishermen, but even in the impure waters of the extreme inner harbor, where they are frequently caught by boys fishing for flounders. A specimen taken in this manner was found by Capt. Collins in the taxidermist's store, and forwarded to Professor Baird. It proved to be the true deep-sea cod. One fisherman, while obtaining bait for his lobster-pots, during the early spring of 1883, frequently caught as many as a hundred pounds of these fish in a single catch. This same fisherman informed me that at least three or four generations were plainly distinguished, the smaller being much more abundant. From only one other point along the coast was I able to find this species of cod reported in the shallow water. A school was encountered by a Gloucester vessel close in by Mount Desert,

and fourteen barrels obtained. They all measured within an inch or two of fourteen inches, — just the size of those reported from Gloucester, and exactly as long as the specimen obtained from that locality. I obtained two specimens from the Mount Desert school, which are at present in the National museum. Here we find, in a limited area, great numbers of a fish now inhabiting only the deeper waters; this fish for many years having been a total stranger to the locality in which it is at present so abundant, and not found, so far as is known after many inquiries, in other similar places, with but a single exception. The oldest and most observing fishermen never remember a similar instance; and all come to the conclusion, that they are the result of the hatching operations in 1879, those from Mount Desert being but a small portion of the larger school migrating from their given home. Certainly other than natural causes must be looked for to explain this sudden increase in a small, unfavorable locality: so, as a very convenient and satisfactory explanation is found, with evidence to back it, we will say with the fishermen, 'These must be Fish-commission cod.' They will of course migrate in time; for it is hardly to be expected that they will return to their first home after once finding purer water outside.

Undoubted good must come of the future operations, for millions and millions of eggs which would otherwise be spoiled will be hatched; the young reared, and placed in the water to live and reproduce; and thus the waters will become restocked with a species of fish which is growing scarcer every year with frightful rapidity. These unexpected results of the experiments prove beyond a doubt that even deep-sea fish can be kept under control by the same means that the stock of river-fish is regulated.

While at Gloucester, Professor Farlow, by request of Professor Baird, investigated the nature of the so-called 'reddening' of salted cod, which caused such ravages during the warm months, with the idea of furnishing a remedy. This peculiar 'reddening' was found to be caused by an alga (*Clathrocystis roseo-persicina*) which was abundant on the marshes near Gloucester. In many of the fish-houses the alga was present in large quantities on the walls, on the flakes, and even in the vessels, probably having been introduced there by the fishermen on their clothes, or from the mud on their boots. Furthermore, it existed to a considerable extent in the Cadiz salt, which was used in preference to Trepani

salt on account of the cheapness of the former. Trepani was, on the contrary, found to contain very little. Dr. Farlow advocated that the walls and all the wood-work be scraped, and washed in hot water to kill the plant, and that painted wood be used in preference to the rough natural walls in order to afford as little room as possible for the *Clathrocystis* to lodge itself. He further advised that Trepani salt be used instead of Cadiz. A number of fish-dealers have adopted his suggestion in regard to the salt, and they all inform me that for two summers not a single fish has been lost by 'reddening.' The wood-work contained the plant; and in warm weather old butts turned red on the outside, while the new ones, in which no pickle made from Cadiz salt had been kept, remained perfectly intact. The fish saved by this means more than paid for the difference in price between the two salts. Trepani salt seems to prevent the rapid growth of the plant, while Cadiz rather favors it. Here, as in many other cases, we see that a little scientific thought will accomplish that which would never be brought about without it.

RALPH S. TARR.

MUSEUMS OF NATURAL HISTORY IN THE UNITED STATES.¹

THE state of its public museums, laboratories, and other scientific institutions, gives a very reliable measure of the appreciation and culture of science by a nation. We are often inclined to consider America as a country where money-making suppresses all other interests, where learning, art, poetry, — in one word, all the finer manifestations of the human mind, — can enjoy even a poor existence only in a few places, and find in general very unfavorable ground. One, however, who has had an opportunity of carefully observing American literature during recent years, could certainly not help seeing its intellectual activity; most of all, perhaps, in the case of the sciences, they being intimately connected with practical life, and among these especially those of geology and paleontology. Most of the states created geological surveys for the investigation of the country, and the publication of maps and other results: the general government extended these investigations to the territories. The elegant publications of these geographical and geological institutions, distributed with the greatest liberality, form already a library which contains information of the greatest value concerning the vast country of the United States.

We have often enough heard that they were founding public museums in America, and that, together with their indigenous treasures, they were desirous of obtaining the material of the old world for com-

parison, if, as now and then happened, a valuable private collection had to make its way across the ocean. It would form a long 'list of the missing,' should we enumerate all the valuable scientific objects, which, during the last thirty years, have gone to America from Germany alone. The contributions of England and France towards the enrichment of the transatlantic museums are, of course, not less. But, in spite of all this, the American museums are hardly known among us. While among the eminent learned men of America there are only a very few who have not travelled in Europe at least once, the new world is usually not studied with the same care by the learned men of the mother-countries. The Americans, however, have begun to make their treasures in natural science accessible to the public, as well as to the specialist, in a way which in many respects deserves admiration and imitation.

The following observations on some of the most prominent museums of natural history, made during a short stay in North America, will undoubtedly prove to be incomplete, one-sided, and perhaps in many respects even inaccurate. Their main object is merely to call the attention to those institutions more carefully than has hitherto been done.

Up to the middle of this century, Philadelphia was at the head of scientific investigation in America; and even to-day, when the principal city of Pennsylvania has almost lost its leading position, a visit at the fine museum of natural history will show everywhere the traces of a celebrated past, and of a comparatively old civilization. Among all the larger museums of North America, the museum of Philadelphia shows the strongest European influence in its whole organization, and in the arrangement of the collections. The handsome building belonging to the Academy of natural sciences is in the centre of the city, near one of those beautiful squares full of trees which are the pride of Philadelphia. The first floor contains a rich library, the meeting-rooms of the academy, rooms for officials and for special investigators. The collections are in the upper part of the building, in one large hall surrounded by wide galleries. Stuffed mammals, skeletons, and several large fossil vertebrates occupy the centre of the vast room. Among them a fossil gigantic saurian, with its strong hind-legs and short fore-legs, is conspicuous by its enormous size. The bones which were found at the 'Hopkins' farm in New Jersey, and which furnished the material for the restored skeleton of the *Hadrosaurus*, have been well prepared, and are now kept in show-cases near by, together with the remnants of another gigantic fossil lacertian (*Laelaps*), and together with the nearly complete skeleton of an *Elasmosaurus*, found in the chalk of Kansas, which has much resemblance to *Plesiosaurus*. The restoration of the *Hadrosaurus* was made before the time of Marsh's great discoveries, and before the twenty-four skeletons of *Iguanodons* had been found near Bernissart in Belgium. We must therefore not too severely criticise a few errors made by the restorer in the restoration of the missing parts. By the purchase of the collection of birds from the famous

¹ By Prof. K. A. ZITTEL of the University of Munich. Translated from the supplement to the *Allgemeine zeitung* of Dec. 16.

ornithologist, Gould, Philadelphia got a first-class ornithological museum. For craniologists, Dr. Morton's collection of about twelve hundred skulls is of interest. The collection of recent shells is said to be second in completeness only to that of the British museum, and is rich in originals used in the publications of a large number of active scientific men in Philadelphia.

Through Professor Joseph Leidy, the director of the museum, Philadelphia was the first place to procure the remains of fossil mammals from the territories of Wyoming, Dakota, and Nebraska. By this excellent *savant*, attention was called to those inexhaustible treasure-houses in the far west from which, since that time, a whole world of marvellous fossil animals has been unearthed. The interest of the specialist will be attracted by Professor Gabb's collections made in California and Nevada, and by the petrifications from the tertiary formation in Georgia and Alabama. The museum is also rich in European objects.

The interior arrangement is simple but practical. Sometimes the show-cases are rather crowded, and stand so near together that the light is not everywhere sufficient, in spite of the high windows on all sides of the hall. Already in this comparatively new building there is, as in nearly all European museums, a lack of space.

Naturalists will not leave Philadelphia without having seen Prof. E. D. Cope's celebrated collection of fossil vertebrates. During my stay in Philadelphia, this indefatigable investigator was in New Mexico in order to continue the exhumations with which he now has been occupied for many years at a heavy expense, and with much personal hardship. Very soon his elegant house in Pine Street became too small for the collected treasures, the house next to it had to be bought, and now it is filled from top to bottom with fossil bones. And again no space was left: the larger specimens, therefore, had to be placed in the cellars of a public building. Mr. Wortman, a former pupil and assistant of Professor Cope, was my amiable and well-informed guide through this improvised museum, where almost all the rooms are filled nearly up to the ceiling with cases, shelves, drawers, trunks, and boxes, where one finds piled on the floor, or along the walls, enormous skulls of mastodons and Dinocerata, or bones of gigantic saurians, and where the visitor's eyes are delighted with several complete skeletons of mammals still remaining in their stony matrix. Besides a number of forms already known by way of pictures or descriptions, one may see here the remnants of several hundred fossil vertebrates of which we in Europe know hardly more than the names. Comparing the fossil mammals of the Paris basin with those found in North America in strata of the same period, we discover a striking difference between the two faunas.

The regions of geographical distribution for vertebrates were just as sharply limited during the tertiary period as nowadays. This is the reason why we find a nearly inexhaustible abundance of new orders and species in the so-called Bad Lands of western Amer-

ica. Professor Cope is one of the most eminent authorities of our time in comparative anatomy and paleontology: he has bought the fine osteological collection of Hyrtl at Vienna, and is now busy in editing an extensive work, in which he intends to give descriptions, as well as pictures, of the numerous fossil mammals discovered by him.

While Philadelphia has the oldest museum of North America, Washington is arranging the newest one. In the elegant, beautifully situated capital of the country, with its wide and clean but hardly animated streets, with its vast parks and magnificent edifices, the visitor will be surprised to find unfinished, not only the Washington monument, but also various other edifices. But if once all the enterprises which are now going on are finished, Washington will be one of the most beautiful cities of the world. Not far from the simple home of the President there is a park of about fifty acres, in which we find most imposing public buildings, among them the green-houses of the botanical garden, the Smithsonian institution, and the National museum. The latter is in a palace of red sandstone. The interior of the tasteful building, in Normano-Gothic style,¹ contains in the centre a dome-like hall two hundred feet long, where various collections in a somewhat strange mixture are accommodated. Large glass cases with stuffed animals are put together with Indian curiosities, models, and relief-maps, together with samples of building-materials and ores. Part of the hall and a wing of the building are given to the geological survey. In the other wing we find the excellently arranged prehistoric and ethnographical collection, under the direction of our countryman Karl Rau. The great variety of the tools and weapons made of stone, still used among some Indian tribes, which are exhibited here, is hardly less remarkable than the ability with which these savages work the brittle material. In this respect the American autochthones have undoubtedly attained a higher civilization than the inhabitants of Europe during the stone period. For the present, the National museum, as a whole, can be considered merely as the beginning of a museum of almost universal character; but, with the enormous means which are at the disposal of the central government, it needs only a few influential and energetic men to develop great things out of this promising germ.

A glance at the growth of the American museum of natural history in New York shows what energy, and readiness to sacrifice, may accomplish within a few years. In January, 1869, a few scientific friends met, and decided to found in New York, the metropolis of North America, a museum of natural history, which was to correspond with the means and the importance of this city, and to give its inhabitants an opportunity for recreation and instruction. Within a few weeks forty-four thousand dollars were subscribed. Out of this money the collection of birds made by Prince Maximilian of Wied was bought. Many other objects were given; and very soon the

¹ The writer has here confused the Smithsonian and museum buildings.

halls of an armory, assigned by the city to the museum, proved to be too small. Thereupon the trustees thought of having a home of its own for their collections; and to that end the city government not only gave Manhattan Square, an estate of eighteen acres and a quarter, in the immediate vicinity of Central Park, but also decreed the necessary means for the projected building.

In June, 1874, the corner-stone was laid, in the presence of President Grant, the governor of the state, the mayor of the city, and a number of prominent persons from Boston and New Haven. As early as December, 1877, the large fire-proof building, consisting of nothing but stone and iron, was finished so far that it was possible to transfer the collections, and to make them accessible to the public. To-day the museum is already filled to such an extent, that the trustees ask for three hundred thousand dollars more, in order to put up an additional building of the same size. In regard to the excellent adaptation of the building to its purposes, and also in regard to the practical interior arrangement, the New-York museum deserves to be called a model institution. The exterior of the red-brick building is without any ornamentation. The entrance at the narrow side leads to the basement: the large staircase is opposite. Each floor contains, besides one single large hall of a hundred and seventy by sixty feet, only a few small laboratories near the stairs. Wide and high windows on both sides furnish plenty of light. Between them the walls have openings like loopholes, through which the interior of the cases, which are in a rectangular position against the side-walls, get the necessary light. The wide, well-ventilated halls, provided with heating-apparatus and gas, make a grand impression. On all the floors the main cases are arranged in the same way, and are of the same size; so that it would be easy to move the contents of one hall into another. The rooms, as well as the cases, are well protected against dust. The cases are made of iron; their doors, of a single pane of glass. The tasteful and appropriate furnishings correspond with the contents. In the basement there is a rather small collection of mammals. We do not see here those shabby skins, half-destroyed by moths, nor those ill-shaped, four-legged straw bags which disfigure so many museums of older date. Every thing is new and clean; and some groups — as, for example, the family of orang-outangs, or the *Ornithorhynchus*, with its surroundings — may well be called pictures borrowed from nature. The collection of birds on the first floor deserves similar praise. The laymen will be pleased with the birds of paradise, the macaws, the parrots, and the humming-birds, which display here the beauty of their feathers. The hall of the first floor is thirty feet high, with a wide gallery, forming, so to speak, a floor for itself, with its own windows. Here we find a rich ethnographic and prehistoric collection. American objects predominate; but there is no want of foreign material for comparison, and especially one interested in the European stone period could find here very many valuable things. The next floor contains the geologico-paleontological and the

mineralogical collection. The nucleus of this division is a collection bought for sixty-eight thousand dollars, from Prof. J. Hall in Albany, the Nestor of American geologists. The typical objects, as given in Hall's voluminous work on the state of New York, are arranged here in a way that affords an excellent view of the whole; and I do not think that the enormous mass of paleozoic petrifications of America is better exhibited in any other museum. On the highest floor there is a library, a hall for public lectures, laboratories, and a number of rooms for various specialists and their private collections. A freight-elevator runs from the cellar to the highest floor in an American museum, as a matter of course.

If we consider what has been done in New York within less than fifteen years, we have, indeed, to admire the energy of the superintendent, Prof. A. S. Bickmore. He not only knew how to get some of the richest and most influential citizens interested in his work, but also formed, with the means at his disposal, an institution unrivalled in many respects. The American museum of natural history is open to the public daily; and, on an average, about fifteen thousand persons a week make use of this privilege. The city of New York pays to the museum annually fifteen thousand dollars. All the expenses above that are paid by subscription. Should the plan, as exhibited in the basement, be carried out, the museum would have twelve buildings of the size of the present, which, together with six connecting wings, would cover the whole of Manhattan Square. An enormous cupola would form the centre of the whole. Then New York would decidedly have the largest museum of natural history in the world.

The museum of the state of New York, at Albany, is on a smaller scale. This institution has been founded by the celebrated geologist, J. Hall. During fifty years of investigation he has unearthed the geological and paleontological treasures of his state; and, besides a private collection, he has created a public museum, where the products of the state of New York are exhibited in a fine arrangement. In Germany we have only one local collection, the 'Württembergisches landes museum,' at Stuttgart, which is ahead of the museum of the state of New York in regard to arrangement and completeness.

For study and investigations, the capital of the state of New York, with its unpleasant political life, is not a very favorable place. The university towns of New Haven and Cambridge are far better homes for intellectual culture in North America. There is no better introduction into society than a diploma from Yale or Harvard. These universities are partly imitations of English colleges, partly of German institutions; and for decades there have been first-class learned men among their teachers. The scientific life of America is under the influence of these universities and these independent corporations are so popular that they receive considerable legacies nearly every year. The numerous handsome buildings of Yale college at New Haven show the wealth of this institution. Among the simple dormitories and buildings for lecture-rooms, the museum of

natural history attracts the attention by its height and a fine Gothic front. It owes its existence to a gift of Peabody, the well-known philanthropist. The first story is occupied by a collection of minerals most excellently arranged, by the private laboratories of Professors Dana and Brush, and by lecture-rooms and common laboratories. The middle floor contains the geological and paleontological collection. The highest floor contains collections for zoölogy and prehistoric ethnography.

The centre of interest at New Haven is a collection of fossil vertebrates founded by Prof. O. C. Marsh. Not only the whole first story, but also cellar and attic, are filled with fossil bones. Long rows of piled-up boxes contain the paleontological treasures. Only a very strict order makes it possible to find every thing in these crowded rooms, where a number of assistants are busy in preparing and combining the objects which so often arrive in fragments. In a small additional building a German modeller forms casts of the finest specimens, and afterwards these casts are sent with the greatest liberality to American and foreign museums. To a large extent, the Peabody museum owes its fine condition to the self-sacrificing activity of Professor Marsh.

What at the beginning of this century Cuvier did in Europe for the knowledge of antediluvian vertebrates, has been done in America by Professor Marsh, and his not less active rival Professor Cope in Philadelphia. The great variety of fossil vertebrates in America corresponds with the vastness of the country. Whole cartloads of bones have been dug out in the Bad Lands of the far west: they were carried on the backs of mules hundreds of miles, before they reached the railroads which brought them eastward. For months Professor Marsh and his assistants were camping in the reservations of the Indians, protected by an escort of cavalry. With the great chiefs of the Sioux, 'Red Cloud,' 'Red Dog,' he used to smoke the pipe of peace: against others he had to defend himself, revolver in hand. Professor Marsh's collection of fossil remains of vertebrates, brought together within about fifteen years, is not less complete, and not inferior in value to the collection of the British museum in London. It is infinitely more than all the material ever seen and studied by Cuvier during his whole life. During my visit at New Haven there were about twenty-five gigantic skulls of Dinocerata in the professor's laboratories. Several lithographers were occupied in making plates for the publications in which the fossil mammals and reptiles of America will be described. In an adjoining room a whole series of teeth, and bones of the foot, illustrate the development of the horse species. Though the Indians made the acquaintance of the horse only through the Spanish 'conquistadores,' there is no country where remains of antediluvian horses are so often found as in America. A series of fossil species shows the changes which the ancestors of the horse underwent, before the present type of the solidungulate was attained. Europe, also, has some of the intermediate forms, but not so many. The American predecessors form a

nearly uninterrupted series. From the enormous mass of antediluvian mammals I can mention here only the oldest forms from Jura and tertiary strata, which have been discovered lately in America. Up to that time we knew only several lower jaws found in England, and a few teeth from the keuper of Wurttemberg.

Professor Marsh has brought from Wyoming remnants of at least three hundred specimens, and not only lower jaws, but also skulls, and other parts of the skeleton. They belong, without exception, to little marsupial-like species, usually of the size of a rat or squirrel. In contrast with these dwarfish forms, the reptiles of the Jura and chalk formations excel usually by their gigantic size; and it is just the largest and the clumsiest of them that show a remarkable combination of reptilian and avian peculiarities. New Haven has the largest collection of such dinosaurians. There you may see a complete skeleton of the curious Brontosaurus, — an animal with a small head, a long neck, long tail, high hind-legs, and short fore-legs.

The upper part of the femur of the gigantic Atlantosaurus is about twice as long as the corresponding bone of an elephant. The curious Stegosaurus, thirty feet long, was covered with an armor of enormous bone plates, and armed with thick spines. The cavity of its brain was of a minimum capacity; but, in compensation therefor, the spinal marrow in the os sacrum is swollen into a second brain-like enlargement. Another little saurian (Coelurus) has ring-shaped vertebrae which are entirely hollow. Hadrosaurus has shining teeth, jagged on the sides like shark's teeth, in several rows above each other, and side by side, so that they come into use only one after another. Besides these dinosaurians, some snake-like saurians of the sea, with short swimming-feet (Mosasauridae), attract our attention. A slab three metres high contains a complete well-preserved skeleton of such an animal. On the whole, Professor Marsh may have parts of about sixteen hundred specimens.

America has also flying saurians; though the skeletons are not often so completely preserved as those in the lithographic slate of Bavaria, but they are of considerably larger size. The skull of a Pteranodon, for instance, is three feet long. While this flying saurian differs from its European relatives by toothless jaws, there are in the chalk strata of America a number of birds with well-developed teeth. Professor Marsh has given a description of these curious creatures in a very elegantly executed monograph.

A visit at the Peabody museum, under Professor Marsh's guidance, arouses very mixed feelings in a European colleague. Together with sincere admiration, he necessarily has the disheartening conviction, that, whereas the time of great discoveries has begun in America, it is over in Europe. The character of greatness and magnitude which we find in many conditions of American existence is also prominent here. Compared with the paucity of the discoveries in our own country, the virgin soil of America furnishes, uninterruptedly, new and unexpected objects.

It is beyond question that the future development of geology and paleontology will be essentially influenced by America; but it seems to me, that, for zoölogy also, a model institution for the future, in many respects, has been created in the celebrated Agassiz museum in Cambridge, near Boston, which probably will not be without influence on the development of museums of natural history in Europe. On an extensive plot near Harvard university there has been erected a five-story brick building with numerous windows, but with no ornamentation, and with an almost barrack-like appearance. The simple staircase corresponds with the modest exterior and with the whole interior arrangement. The genial founder of the 'Museum of comparative zoölogy,' as he called it, did not intend to have a brilliant exhibition, but a place for serious labor and study. And the great enterprise called into existence in 1860 by Louis Agassiz has now been nearly completed, according to the ideas of the father, by the energy and the organizing talent of the son. Over three hundred thousand dollars were subscribed in a short time, when Louis Agassiz, twenty-four years ago, came to America, and announced a plan for the erection of his museum. Nobody knew better than he how to arouse the enthusiasm of others for ideal purposes by the power of words; and we may well say that he originated that new movement in the descriptive natural sciences which continues up to the present day. A whole school of young zoölogists grew up at Cambridge. Collections of all kinds were bought in the old and in the new world, expeditions were sent to far-away countries, and the depths of the sea were investigated. The ingenious investigator, who was always full of new ideas, had neither time nor patience for the sifting and arrangement of the extremely rich material: his son and successor undertook this task. As an administrator, Alexander Agassiz may be equalled only by a few; as a naturalist, he belongs, as his father did, to the first names of America. A large fortune, acquired in the copper-mines of Calumet and Hecla, near Lake Superior, makes it also possible for him to promote the interests of the museum financially. To him it must be attributed, that the museum has been entirely withdrawn from the influence of an often-changing government, and has been transferred to Harvard university.

In the well-lighted basement of the museum there are eight rooms assigned to the collections in alcohol, which consist not only of lower animals and fishes, but also of numerous mammals, birds, and reptiles in metal boxes filled with alcohol. A seawater aquarium, a room for the preservation of living animals, and various other storerooms, occupy the rest of the basement.

On the first floor, there are the paleontological and geological collections, together with the necessary laboratories and lecture-rooms. The parts of the collection devoted to scientific investigations are separated from the collections for the show-cases proper; and in those, only a comparatively small selection of objects is exhibited. The second floor contains the rooms of the curator, a rich library, laboratories for

anatomical and physiological investigations, and other workrooms for more advanced students and specialists. Besides the rooms already mentioned, there is on each floor a so-called synoptic room, through which every visitor of the museum has first to pass. A small but well-selected collection gives here a general view of the most important representatives from all classes of the animal kingdom. Large inscriptions on the walls and on the cases make it easier to find one's way. All the specimens are accurately labelled. Dissected preparations explain the anatomical structure of crabs, insects, echini, starfishes, etc. The synoptic room for zoölogy may well be called a model of a collection for purposes of instruction. A similar collection for geology and paleontology is in preparation.

While the two lower floors are chiefly devoted to purposes of instruction, the specialist will find in the three upper stories abundant material for his investigations. The third floor contains a zoölogical collection accessible to the public. In five halls all the more important species and varieties are exhibited in systematic order, and not crowded together. For the vertebrates the stuffed skins, as well as the skeletons, are given.

The zoögeographical collection is a specialty of the Cambridge museum. In two well-lighted halls one finds the whole fauna of America. The typical specimens of the animal kingdom of Africa, of India, of Europe and Siberia, and of Australia, are represented in their respective rooms. A special hall has been reserved for the inhabitants of the ocean; and here it is intended to place the rich treasures acquired by the investigations of the depths of the American seas. Most probably several years will pass by before the arrangement of this extremely interesting division of the museum will be finished,—a collection which will be unique in its way.

In the two highest stories the large and strictly systematic main collection of geology is stored in simple but appropriate cases with glass doors. Thousands of skins of mammals and birds are stored up in drawers. The lower animals are deposited in a similar manner. Every case and every drawer bears a label showing its contents. In many departments Cambridge is said to be even ahead of the British museum. Excellent methods of preparation have been applied with fishes and reptiles. The collection of insects, under the direction of the German entomologist, Dr. Hagen, excels by reason of its abundance of beautiful preparations, showing the whole development of the more important species and varieties.

By a mere hasty visit to the exhibition-rooms no one will get an idea of the magnificence of the Museum of comparative zoölogy. Neither the building, nor the rooms inside, nor the exhibited objects, will make an especially imposing impression. But the strong point of this institution lies in the peculiar arrangement of the collection for the public, and in the strict separation of the large material for scientific investigations. By the constant development of science, by the improved accessibility of distant continents

and islands, by the investigations of the depths of the ocean, collections of natural history will be enlarged almost to infinity; and it will be harder and harder to place them in our museums, and to preserve them. Everywhere buildings begin to be insufficient; and if we were to stick to the old system, according to which a museum exhibits nearly all its objects, the large central depositories of natural history would grow to an enormous extent. The organization of the Cambridge museum tries to meet equally the demands of

modest existence of a learned man to a materially better-paying occupation. In this respect Europe is still far ahead. Circumstances, however, will change, together with the great development of North America; and in some of the Eastern States an alteration can already be noticed. We must therefore keep our eyes open, if we do not wish the experience of having our young cousins across the ocean outstrip us in a field the thorough culture of which, so far, has been the glory of old Europe.

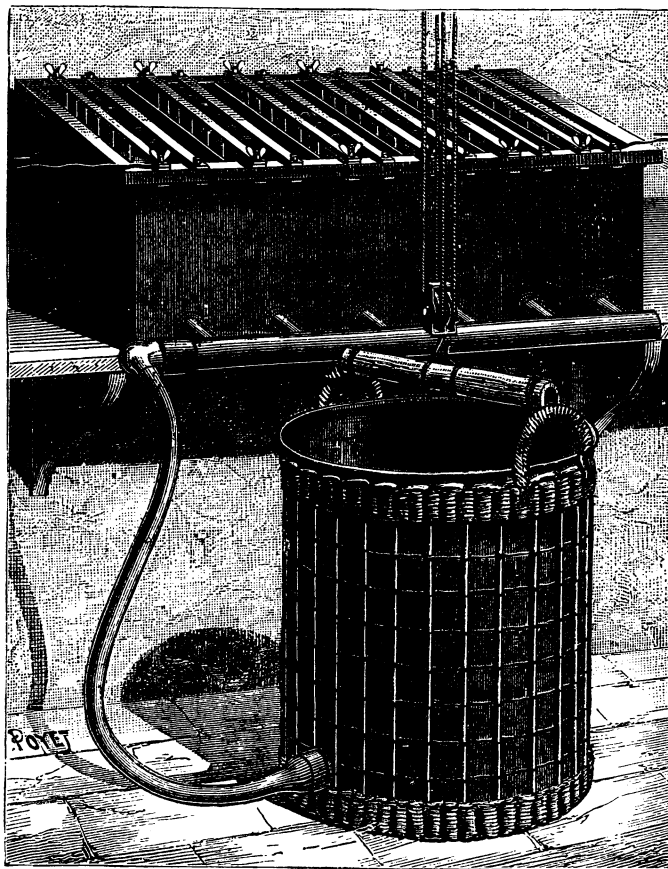


FIG. 3. — Batteries for Tissandier's balloon.

science and the wants of the public which comes for information; and in this sense I have called the Agassiz museum a model museum for the future.

Besides the institutions here mentioned, there are in many other cities of the United States — as Chicago, San Francisco, St. Louis, Cincinnati, Princeton, Baltimore, Charleston, Providence, etc. — smaller museums of natural history. They are almost all supported by societies or schools. There is, therefore, no lack of interest in scientific studies; nor is money wanting. But still the number of those is very small, who, out of pure enthusiasm for science, prefer the

TISSANDIER'S ELECTRIC BALLOON.¹—II.

As we have described our apparatus as a whole, we will now give some details concerning the various parts, and especially concerning the dynamo-electric motor and the bichromate of potassium battery, which was prepared with a view to our experiments.

The motor is a Siemens new model machine, made at Paris especially for us, consisting of a bobbin very long in proportion to its diameter, and mounted on a light wood frame. This machine weighs only fifty-

¹ Concluded from No. 53.

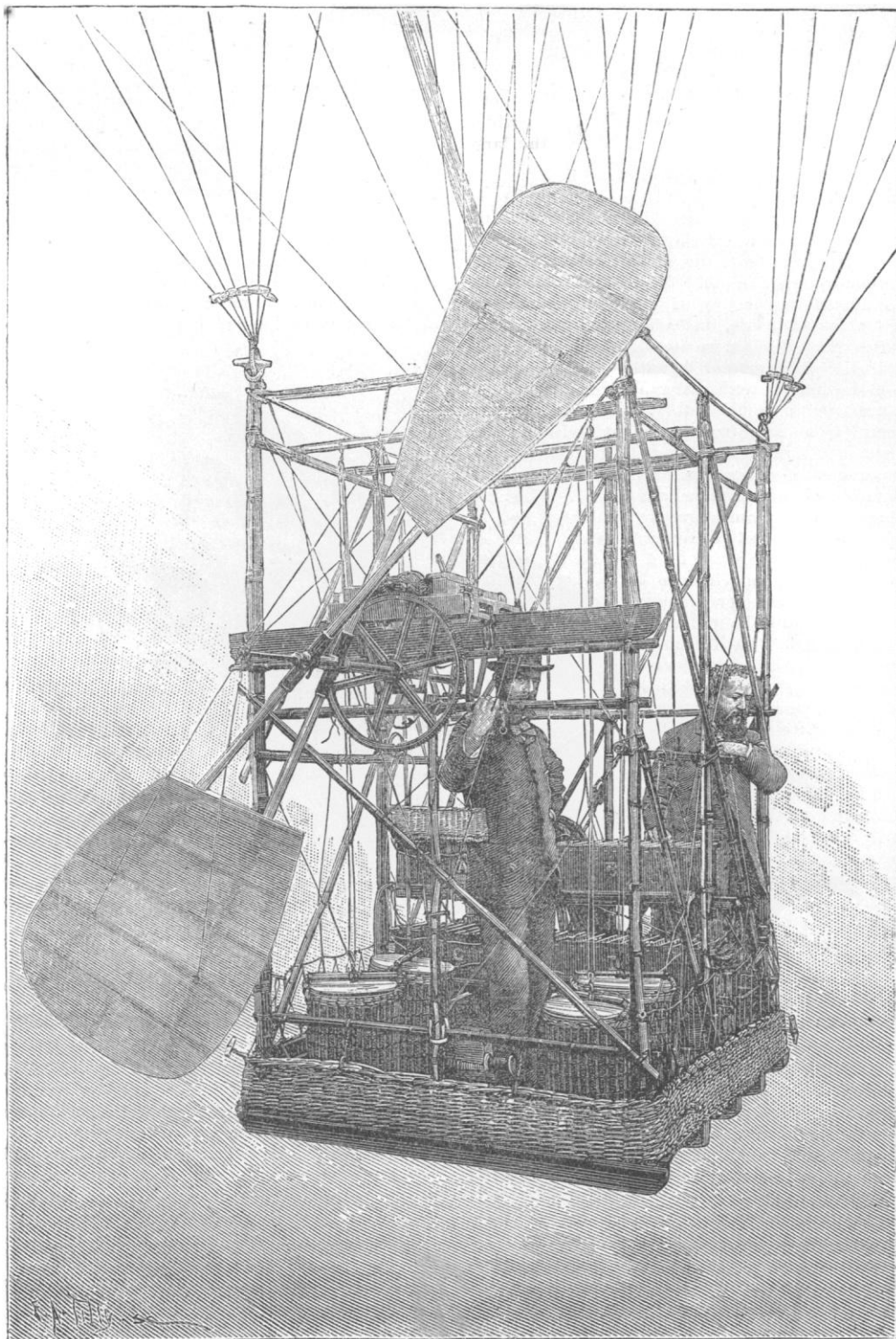


FIG. 4.—BASKET OF TISSANDIER'S FLYING-BALLOON.

four kilograms. The screw consists of two helicoidal pallets covered with varnished silk, the deformation of which is guarded against by the action of coils of steel wire. This screw is 2.85 metres in diameter: it is attached to the machine by a transfer and by gearing, and makes a hundred and eighty revolutions per minute, while the bobbin makes eighteen hundred.

The electric battery, which may be called the generator of the screw balloon, has the same surface of zinc and carbon as our trial batteries, the measurement of which has already been given elsewhere (*La Nature*, May 20, 1882), the same number of cells, the same volume of liquid. We are able to considerably reduce its capacity by using four ebonite troughs with six compartments, instead of twenty-four separate receivers. Besides, we use slightly higher vessels, which also gives greater breadth. Fig. 3 presents one of the four batteries used in the electric balloon as it was tried in the laboratory. It consists, as may be seen, of one large trough with six divisions; each compartment forming an element of the pile, enclosed and mounted on copper legs, having eleven thin carbons and ten zincs arranged alternately. The zincs are held in place from above by flexible pincers, and may easily be renewed after each experiment: they are .15 of a centimetre thick, sufficient to work the battery for three hours. They must be perfectly amalgamated. Each compartment is provided at its lower part with a slender ebonite tube, which communicates to a lateral conduit connected by a caoutchouc tube with a large and very light ebonite vessel containing the acid solution of bichromate of potassium. If the pail is raised by means of a string passing into the blocks above the level of the battery, the latter is filled by the chief communicating vessel, the liquid acts on the zincs, and the current passes: if the pail is lowered, so that it occupies the position seen in fig. 3, the liquid enters by the caoutchouc tube, the battery becomes empty, and ceases to act. By this system it is apparent that the piles communicate with each other solely by the narrow conduits. The resistance of the liquid is great enough for this communication to have no effect on the current, although the elements are in series. In the car there are four batteries like that shown in the figure, of twenty-four elements, in series, and fed by four pails of ebonite, each containing thirty litres of the bichromate of potassium solution. The batteries are stowed away in the car (which is 1.9 metres long and 1.45 metres broad) so as to occupy the least possible room. Two ebonite troughs of twelve elements are placed cross-wise about .35 of a metre from the bottom of the car, and there are two more .15 of a metre higher. The ebonite reservoirs at the two back corners of the car feed the upper piles; and the other two reservoirs, nearer the battery, feed the lower piles (fig 4). A

vacant space is left between the four pails for the operator, who controls every thing, having at hand the cords to raise the pails, the hooks to hold the cords at the desired height, the commutator with the cup of mercury to start the current, and the cords the rudder.

The bichromate of potassium used to work the battery is concentrated and very acid: it is turned into the pails at a temperature of about 40°, which permits of a considerable increase in the quantity of dissolved salt. The commutator is so arranged that a current of six, twelve, eighteen, or twenty-four elements may pass; and thus the screw has four velocities. The four pails are covered with a sheet of caoutchouc, pierced with one small hole, which allows the air to pass when the liquid is flowing, and is bound

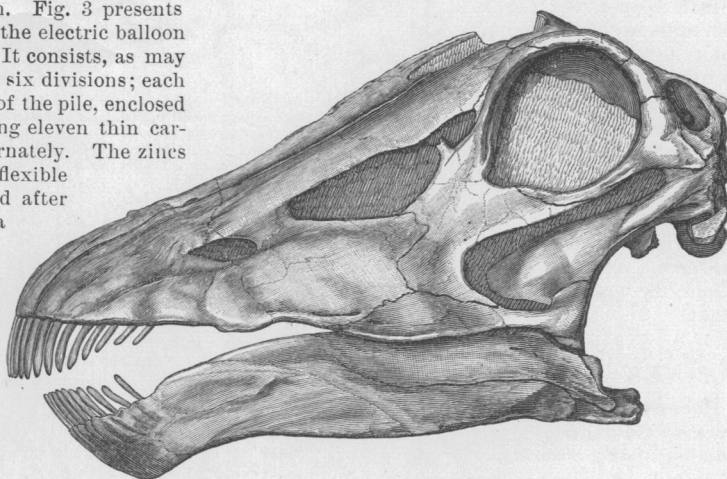


FIG. 1. — Skull of *Diplodocus longus* Marsh, side view.

around the pail by a copper thread sheathed in gutta-percha. This manner of closing is very secure; and, in case of a shock, not a drop of the liquid can escape. The pails, when empty, weigh only three kilograms each: they are strengthened by basket-work, which also serves as a support. Cords passing into the pulleys raise them above the piles in order to fill them, and lower them to empty them. The bottom of the car holds a caoutchouc cistern to receive the liquid in case of accident. The pile with the liquid weighs about a hundred and eighty kilograms. A little willow basket—easily seen in our illustration—is placed under the motor. It contains an oil-can for the motor, a little bottle of mercury to supply the cups of the commutator sunk into a block of box-wood, and also the tools necessary to discharge the pile in case of accident. All this occupies the back of the car. In the front, space is reserved for the ballast-bags and for the implements used in the descent.

Our illustration was made with great exactness: it presents all the details of the arrangement of the car, and shows the attachment of the motor. The

Siemens machine, and the spring which it works, are arranged on a walnut cross-piece. In addition, it is held by stretched ropes, which may be tightened at pleasure by tension, and which connect the four extremities of the framework with the upper and lower cross-pieces of the car. When rotating with great velocity, the vibrations are avoided by this method of attachment.

The use of such a machine in the car of a balloon is comparatively simple. When every thing has been prepared on the ground, there is nothing to do but to plunge a little copper fork into the mercury-cup of the commutator, and the screw begins to turn.

From fear of fire, and from the change of position, which affects the altitude of the balloon when once poised in the air, the operator must have no manual work to do: electricity alone supplies all the fundamental conditions of the aerostatic motor-force. After the winter, when favorable weather comes, the first electric balloon will again take its flight.

GASTON TISSANDIER.

A NEW AND STRANGE DINOSAUR.

PROFESSOR MARSH continues his studies of the Jurassic dinosaurs of America by giving, in the last number of the *American journal of science*, an account of a new family of Sauropoda founded upon the genus *Diplodocus*, which he places between the Atlantosauridae and the Morosauridae. The chevrons of the caudal vertebrae, which have both anterior and posterior branches, have suggested the name *Diplodocus*; and the ischia of the pelvic girdle are intermediate in form and position between the families heretofore recognized, the shaft being straight, and not twisted nor apically expanded.



FIG. 2. — The same skull, front view.

But the best preserved portion is the skull, of which we reproduce Professor Marsh's excellent figures. It was of moderate size, the figures being one-

sixth the natural size, and showing clearly the characteristic features. It has two pairs of ante-orbital openings, the small front pair not having been seen before in dinosaurs. The brain inclines backward, and has a very large pituitary body, enclosed in a

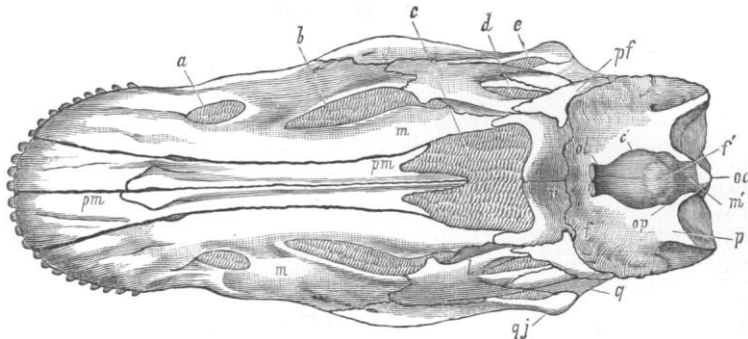


FIG. 3. — Skull and brain cast of the same, seen from above. *a*, aperture in maxillary; *b*, ante-orbital opening; *c*, nasal opening; *c'*, cerebral hemispheres; *d*, orbit; *e*, lower temporal fossa; *f*, frontal bone; *f'*, fontanelle; *m*, maxillary bone; *m'*, medulla; *n*, nasal opening; *oc*, occipital condyle; *ol*, olfactory lobes; *op*, optic lobe; *p*, parietal bone; *pf*, pre-frontal bone; *pm*, pre-maxillary bone; *q*, quadrate bone; *qj*, quadrato-jugal bone.

capacious fossa below the main brain-case, — a very different condition from that holding in the other families of Sauropoda. The size of the skull indicates an animal probably forty or fifty feet long: the weak dentition shows that it was herbivorous, and its food was probably such succulent vegetation as an aquatic life would enable it to procure.

In looking at these figures, and noting their strange resemblance to a horse's skull, one finds it hard at first to recall the fact that the nearest living allies of *Diplodocus* are the crocodiles.

THE FALSE PROPHET OF THE SUDAN.

THE religious movement in the Sudan has a special interest for ethnologists on account of its parallelism with the events by which the faith of Islam was originally propagated. A recent letter from Khartum informs us that Mohamed Ahmed, the Mahdi, was born at Dongola in the year 1260 of the hegira. His parents, Abdellahi and Amina, were poor, and had two older sons. From the age of seven he was taught in a Mussulman school to read, write, and commit to memory the Koran. At the age of twelve he knew the latter perfectly. In the same year his father died; but his brothers continued his education while he pursued studies of the Mussulman law, foreseeing eminence in store for him. After the death of his mother, having completed his studies, he repaired to the Isle of Aba on the White Nile, to be near his brothers, who were boat-builders. For nearly fifteen years he inhabited the isle, venerated as a holy man by all who knew him, before making claim to the title of Mahdi or Mussulman Messiah. He then wrote to all sheiks and grand dervishes of the region, that the prophet

Mohamed had appeared to him in a dream, and informed him, as from Allah, that he was the long-promised Mahdi; that the Turkish supremacy was at an end, the reign of the Mahdi begun; requesting their assistance, and further predicting wars and insurrections for the Sudan. For himself, at the proper time, he proposed to go to Mecca to receive recognition from the grand sheriff. These predictions were circulated at Khartum a year before they came to the knowledge of the local authorities. Finally Raïf Pasha, governor-general, decided to send a deputation, headed by the famous Abu Süüd, to confer with the new prophet. The latter was found in a large hut surrounded by his dervishes, but declined to go to Khartum or to perform miracles, the time for which, he said, was not come. Abu informed him that he would be forcibly taken to the governor if he did not come willingly; but, discovering several men with drawn swords in his rear, he retreated precipitately to his despatch-boat and to Khartum. He was sent back with two hundred soldiers, commanded by an adjutant-major, to bring the Mahdi forcibly. These soldiers landed at night in mud up to their middles, lost all courage, and, arriving at the hut, were confronted by a mob of whirling dervishes. One of these was shot by the commander as a signal for attack, when the remainder, with thousands of Arabs who had remained in ambush, threw themselves upon the little troop, and exterminated them. The boat was next attacked, and was obliged to retreat to Cava. On the 20th of August, 1881, a large force was collected at Cava to crush the insurrection before it gathered strength. Meanwhile the Mahdi and his people left the Isle of Aba under the very eyes of troops who dared not oppose him, and made his way toward the mountains of Gadir. Here, in November, 1881, he was attacked by Rashid Bey and the king of the Shiluk tribe with five hundred soldiers, who were destroyed, almost to a man, in a few moments as it were. Raïf Pasha being superseded, Giegler Pasha, a European civil officer temporarily in charge, declared that he could preserve order with the troops at his command, and declined re-enforcements. In order to carry out this boast, he concentrated the garrisons of Kordofan, Kashoda, Sennaar, and Khartum, and despatched them from the latter place against the Mahdi, under command of Yusuf Pasha. They comprised about seven thousand men, mostly untrained conscripts, with six cannon.

Three days after their arrival at Gadir they were attacked by fifty thousand insurgents, commanded by the brothers of the Mahdi; and only about a hundred and twenty-four private soldiers escaped from the general massacre. The troops of the Mahdi suffered severely, and both his brothers were killed. Meanwhile the other provinces, from which the garrisons had been withdrawn, began to rise against the authorities. Sennaar revolted: the few soldiers there were slain, with all the Europeans, and their goods looted. El Kerim Bey came to the rescue of the government with three thousand Arabs. He was killed, his men slain or dispersed, his villages were

burned, and all the inhabitants put to the sword, without regard to age or sex.

At this juncture Abdelkader Pasha was named to the governorship; and the Mahdi marched on El Obeid, capital of Kordofan, putting the inhabitants of the villages on his way to the edge of the sword. A Catholic mission, consisting of two priests, two sisters, and two lay brothers, were taken prisoners by the Mahdi, and tortured for three days, in a vain attempt to force them to renounce their religion. In September the Mahdi attacked El Obeid with a hundred and ninety-two thousand insurgents. Assisted by a trench, the defenders held their ground for two hours, after which the Mahdi retired, leaving twelve thousand of his men on the battle-field. He proceeded to invest the town, and in four months and a half reduced it by famine, on Jan. 17, 1883. All the Europeans were obliged to embrace Islamism to escape death. Their goods were confiscated. The mission was demolished; the missionaries, male and female, put to the torture. The archives were burned; the merchants of the town, and all the principal functionaries, sold into the interior as slaves. The females suffered rapine.

Before this, thirty-seven hundred soldiers, commanded by Ali Bey, had been sent to succor El Obeid. They were attacked by thirty thousand insurgents under Mama, the grand-vizier of the Mahdi. A thousand escaped to Bara, where they capitulated to the rebels two weeks before El Obeid. But the career of victory was not wholly unchecked. Karkodi on the Blue Nile, the headquarters of the trade in gum and lentils, was captured by the rebels, and partly burned. Four hundred soldiers and merchants were massacred. However, in thirty-five days, the rebels were driven out by the Egyptian troops, and order re-established. A revolt on the White Nile at two large villages, ten hours from Khartum, was crushed, with heavy loss to the rebels, and the death of their leader and his three sons.

Up to this time the insurrection had cost more than a hundred thousand lives in the Sudan. At the time this letter was written, Hicks Pasha and his army were just arrived, and were expected to restore order. Their rout and massacre occurred later. At this date the Egyptian government, under pressure from England, is about to abandon the Sudan to the hordes of the Mahdi; and the unfortunates who are holding a few outposts in the faith of rescue will be left to their fate. The story reads like a page from the middle ages; and it seems hardly credible that such events can characterize any part of the nineteenth century. Unless the strong arm of Abyssinia intervenes against the forces of the false prophet, it is quite possible that even for Egypt proper the end is not yet.

THE GEOGRAPHISCHES JAHRBUCH.

Geographisches Jahrbuch. Vol. ix., 1882. Gotha, Perthes, 1883. 16 + 719 p. 12°.

THIS *Jahrbuch*, an outgrowth of Petermann's *Geographische Mittheilungen*, was first pub-

lished in 1866, under the editorship of E. Behm. On the death of Petermann, in 1878, Behm took charge of the *Mittheilungen*, and H. Wagner succeeded him in the preparation of the *Jahrbuch*, of which the ninth biennial volume has recently been issued. It is about double the size of the first number, and, as now conducted, covers a broad field in geography and allied departments of study, as the following abstract of the contents will show. Indeed, the range of topics reported upon by the thirteen specialists who aid Wagner in its preparation is now so extensive that the seven hundred pages of the present volume are no longer sufficient to contain abstracts of all of the three thousand papers quoted.

The more directly geographical part of the volume contains chapters on the exploration of Africa (42 pages), Asia (35), the polar regions (27), and the oceans (25), by Zöppritz and Lullies of Königsberg, Wichmann of Gotha, and v. Boguslawski of Berlin. From the last of these, we may note the following maps, as embodying the present state of our knowledge concerning the form of the sea-floor. An atlas of thirty-six maps, showing the physical relations of the Atlantic Ocean, was published in 1882 by the German 'Seewarte' at Hamburg. Its first plate shows the depth by eight contour lines at two hundred, a thousand, two thousand, etc., to seven thousand metres, the old fathom measure being discarded. The northernmost Atlantic and adjoining Arctic Ocean are represented in the maps by Mohn, published in supplement No. 63 to Petermann's *Mittheilungen* (1880). The Indian Ocean and the several seas between Asia and Australia are shown in two maps by Krimmel in Kettler's *Zeitschrift für wissenschaftliche geographie* for 1881 and 1882. The latter is especially valuable in illustrating the distribution of temperatures in the sea.

A very considerable share of the work is allowed to questions not simply geographical. Geological investigation is reviewed by v. Fritsch of Halle in seventy-one pages; but only three of these are allowed to the United States, showing a decided inequality of treatment. Studies on the distribution of plants (83 pp.) and animals (71 pp.) are summarized by Grube of Dresden and Schmarda of Vienna; and Gerland of Strassburg reports on ethnology (95 pp.) with satisfactory detail. Geographic meteorology (71 pp.) is safely intrusted to Hann of Vienna. Among the many important memoirs referred to, we may mention Supan's, on the distribution of annual variations of temperature; those by Teisserence de Bort

and Wild, on the relation between isobars and thermic isabnormals; Spindler's paper on the strength and inclination of the wind in storms; and several others on meteorological cycles. Concerning the latter, Hann says, in effect, that the hope that such cycles might afford a foundation for long-range prognostics has proved delusive, and the problem is at present of purely scientific, not practical, interest. Whipple's inquiry into the periodicity of rainfall is quoted as proving the absence of any short cycles of between five and thirteen years' duration, so that it can be definitely said that predictions of wet or dry years on the basis of previous observations are quite worthless. So, also, Hoffmeyer's study of the North Atlantic tempests serves to show the inaccuracy, to say the least, of the *New-York herald's* cable-warnings to western Europe. Forty-four pages are devoted to questions of regional climate.

Dr. Zöppritz of Königsberg is allowed forty-two pages for the progress of terrestrial physics (*geophysik*). In commenting on Professor George Darwin's work on the effect of the tides upon the moon's distance, and on Mr. Ball's entertaining lecture, 'A glimpse through the corridors of time,' on the same subject, the reviewer accepts Professor Newberry's conclusion that the moon must have already attained its actual distance from us when our oldest Cambrian and Silurian strata were deposited. This seems an unnecessary adherence to doctrines of uniformity: for, in the spread of our paleozoic strata, there is evidence of much stronger submarine transportation than we now find; and even in Jurassic times there is a surprising area of cross-bedded sandstones in the region of the Colorado plateau. We agree more fully with the author, in his opinion that Mr. O. Fisher has, in his 'Physics of the earth's crust,' rather overvalued the strength of his conclusions, and again in objecting to the theory of the permanence of continents. Under glaciers, the discussion by Forel, of their periodic variations in Switzerland as dependent on preceding and not contemporaneous climatic irregularities, is regarded as of especial importance. Forel was preceded in this idea by Güssfeldt.¹

Geodesy and cartography are also discussed; and a list is given of geographic societies, which now number seventy-nine, and of geographic journals, which have recently increased rapidly to the number of one hundred and nineteen. Among the societies, the Royal geographical society of London leads the list

¹ Ueber die eisverhältnisse der hochgebirge. Verh. ges. erdk. Berlin, vi., 1879, 86.

with a membership of 3,373, and an income of about nine thousand pounds sterling.

There remain still two chapters to which we hope later to call attention in special notices, — one by Egli of Zurich on the present condition of geographic onomatology, or the study of names; the other, by the editor, on the development of the study and method of teaching of geography, a matter discussed with much seriousness in Germany, though receiving small attention here.

In concluding the present notice, it may be said, that while the *Geographisches Jahrbuch*, like other works of its class, by no means serves the purpose of final reference, it is of the greatest value as an aid in all geographic studies; and the special feature of arrangement according to place makes it a most valuable supplement to other bibliographic works in which the classification is according to subjects.

MASCART'S ELECTRICITY AND MAGNETISM.

Leçons sur l'électricité et le magnétisme. Par E. MASCART et J. JOUBERT. vol. i. Paris, 1882. 8°. *A treatise on electricity and magnetism.* By the same; translated by E. ATKINSON. vol. i. London, De la Rue, 1883. 662 pp. 8°.

ONE feels, in reading Maxwell's treatise on electricity and magnetism, that the author had a grip upon the subject which has only been approximately attained by other writers. Although the style is obscure, and the arrangement often merits the word 'atrocious,' — for equations are taken for granted which are afterwards proved, and other equations are referred to in general without particular specification; so that the student who comes to the book with mediocre preparation, and is determined to master it, cannot fail to have a feeling allied to bitterness with the author who has led him over such a corduroy road to a promised land, — nevertheless, the grip is there, and one always feels it; and each paragraph is full of suggestion.

The treatise of Mascart and Joubert is Maxwell's treatise very much simplified. It has the Gallic flow, but it has not the Scottish grip. It is Cummings's admirable little elementary treatise on electricity, treated by the calculus, and amplified with some of the harder portions of Maxwell. It has the appearance of a collection of excellent professorial notes on Maxwell's book.

The volume now printed contains the mechanical theory of electricity; and a second

volume on the phenomena and electrical apparatus is promised. The portion on thermo-electricity is more extended than the chapter on the same subject in Maxwell's treatise; although, curiously enough, Tait's ingenious method of measuring thermo-electric relations is not given. Much space is devoted to the propagation of what are termed, for convenience, 'electrical waves;' and the action of the telephone is theoretically considered. In the treatment of electro-dynamics the principle of symmetry is often employed in a clear manner. It is noticeable throughout the work that the authors are patriotic, and the special investigations of Frenchmen are often alluded to. We miss, however, full notices of contemporaneous investigations by Germans and by Americans. Perhaps these will appear in the following volume. The chapters on magnetism are very suggestive, and in them the various theories are presented in a clear manner. Thomson's papers on magnetism are given at considerable length, mainly as they are contained in his 'Papers on electro-statics and electro-magnetism.' The view that diamagnetism is merely the difference between the magnetic character of the medium in which the small diamagnetic substance is suspended, and the magnetic character of the substance itself, is popularized by presenting the analogy between this phenomenon of magnetism and the action of bodies floating in fluids of different specific gravities. This hypothesis makes the ether of space a magnetic medium, with a greater coefficient of magnetization than that of any known diamagnetic substance. The analytic processes of the authors are, in general, simple. Laplace's and Legendre's coefficients are used only in a limited way in the subject of magnetism. Perhaps this may be regarded as an advantage in the treatment. What is needed at present is an extended treatise on the application of spherical harmonics to practical problems in electricity and magnetism, and to problems of attracting forces in general, in order to show the availability of this method of analysis.

The authors treat the subject of electro-magnetic induction in a clear way. The retarding effect of induction on the swing of a galvanometer needle is clearly set forth, and the work of electrical motors receives some attention. More will probably be given in the next volume. Hall's phenomenon is treated in a far-off manner. The authors state that "Hall's phenomenon would seem to be in contradiction with the opinion generally adopted, that in electro-magnetic phenomena the action

is exerted on the *supports* of the currents, and not on the currents themselves. But, however we may explain the experiment, it follows that a magnetic field in the stationary state develops an electromotive force which tends to move electricity in the direction of the electro-magnetic action; that is, to the left of an observer placed in the current, and who is looking in the direction of the magnetic force." Perhaps one cannot do more than make the above statement in the present state of our knowledge; but the fact that the phenomenon in question is different in different metals shows the influence of the *supports*. In general, we like the arrangements of the topics treated better than that of Maxwell; and we hope that this book marks the revival of a period of graceful and lucid treatises on mathematical physics which we have a right to expect from Frenchmen.

The English translation of this work by Dr. Atkinson is well executed, and is revised by the authors, who have added certain portions to it which are not contained in the French treatise. We have noticed here and there faults in punctuation which add to the difficulty of comprehending certain relations.

LARISON'S TENTING-SCHOOL.

The tenting-school: a description of the tours taken and the field-work done by the class in geography, in the Academy of science and art at Ringos, N.J., during the year 1882. By C. W. LARISON, M.D., principal of the academy, etc. Ringos, N.J., Larison, 1883. 292 p. 12°.

THIS is an amazingly queer little book, — so full, indeed, of oddities, that one is at a loss where to begin an account of them. In the first place, the author is evidently one of our orthoepomaniacs. Nearly all the vowels, and many of the consonants, are decorated with diacritical points. The result is, that the pages have a singularly bristling and formidable aspect. But we advise the reader to discipline his eye to this painful amelioration of the written speech, for a reward awaits him. Behind this printed '*chevaux-de-frise*' there is a lot of things worth reading. The first effort of the author is to tell just how he managed for the conveyance and camping of a party of students, boys and girls. Every little detail for the construction and equipment of a wagon and camp for eighteen persons is carefully set forth. The most trifling articles are figured in rude woodcuts. All this, though in its way useful, would be tedious but for the *naïve* though often cumbrous language in which it is given,

and the strangely complicated ways of meeting simple needs. When, for instance, he comes to the making of the camp-fire, which the untutored campaigner accomplishes as best he may, our author tells his very ingenious way. The plan is so altogether good, that we give it in full, unhappily omitting the diacritical accents, which are beyond the resources of an ordinary press.

"To kindle fire, we use a kind of strong iron cup, fastened to an iron handle about three feet long. This cup is very wide at the top and will hold about a quart. In this cup, we place a handful or more of resin, a gill or more of kerosene, and about a table-spoonful of a mixture, consisting of one part of ether and four parts of alcohol. At first thought, this may seem to be a very incompatible mixture; but, of its practical value, we have much evidence. To start a fire in wet wood, during a rainy day, under ordinary circumstances, is not easy; but with the arrangement, and the fuel above named, it is readily effected.

"To ignite resin, in the open air, with an ordinary match, is almost impossible. To ignite kerosene in the open air with a match, is not easy; and to fire alcohol in an open pan, with a match, is not done at every trial. Each of these substances require (*sic*) to be heated up to a certain point, — the kindling point, before they will ignite. To raise the temperature of either of these to the kindling point, requires more heat than is developed by the burning of a match; but, ether is so volatile, that when poured out, its vapor instantly rises. This vapor fires at so low a temperature, that when a burning match is brought in contact with it, it ignites with explosive violence, and continues to burn with vigor until consumed. While burning, the heat generated, evaporates the alcohol, raises the temperature of the alcoholic vapor to the burning point, and ignites it. By the burning of the alcohol, the kerosene vapor is raised to the kindling point, and is ignited. The burning of the kerosene soon develops heat enough to liquify (*sic*) the resin, evaporates it and ignites it. At this juncture, a part of the kerosene and resin begins to be converted into a gas that makes a hotter blaze than that made by burning either kerosene or resin alone; besides, attending this fire is much less smoke than is made by the burning of resin alone.

"The cup of burning kerosene and resin, when placed under a heap of wood that is not too wet, soon raises the fuel to the kindling point, ignites it and gives to the fire such impetuosity that it makes water boil quickly, and butter to fry and sputter furiously.

"With the cup alone, charged as above directed, I have boiled a two gallon tea kettle of water in eight minutes. But, this could not have been done in a windy day.

"It would be criminal to make the above statement, respecting the iron cup and the fuel to be used with it, without informing the tiro that it is very dangerous. Should any one attempt to use it, he cannot be too careful. The act of touching it off with a match, unless circumspectly done, may prove very disastrous. The results of using this mixture without sufficient circumspection we have seen. Suffice it to say, they were terrible."

Unhappily, our author does not give a picture showing the effects of these occasional catastrophes on the camp of innocents; but

at least he might have told us how to apply the circumspection.

Like many another victualler of youth, he has very dark views about the hungry camper, or, as he sadly calls him, the 'stomach-man.' He thus exhorts him by picturing the perfect primal man:—

"In reference to this subject, this fact should be kept in view. The type man, the formative man, was symmetrical. Neither his intellectual, nor his sensual, faculties predominated. Temperate in all things, he appreciated and enjoyed the beautiful, the euphonic, the fragrant, the relishful and the eupathic. He suffered,—but to him his task was not onerous; he enjoyed,—but his fruition did not engender ecstasy. Virtuous,—he met what was before him with fortitude. Brave,—he triumphed in every struggle for right. From birth till death, all was satisfactory, all was enjoyable."

The most of the book is filled with accounts of short excursions in New Jersey. They are commonplace enough in their matter, and are only interesting from the indescribably queer tone that pervades them. There are many singular criticisms on the manners and customs of the folk at the summer resorts on the Jersey coast: they are vulgar enough, but the pervading queerness of the text makes them interesting.

This essentially worthless little book meets a growing interest in the free life that the camp alone can give the summerer. Our country with its abundant wildernesses, with the tolerance of its country folk for what would in other lands be called trespasses, lends itself to this charming method of travel. It is much to be desired that some master of the fine art of decent living in rough conditions should give us a manual for the guidance of beginners in its mysteries.

ETHNOLOGICAL PSYCHOLOGY.

Zur naturwissenschaftlichen behandlungsweise der psychologie durch und für die völkerkunde. Von A. BASTIAN. Berlin, 1883. 234 p. 8°.

THE idea pervading all of the more recent publications of Adolf Bastian is to establish a science of psychology of nations upon the data of modern ethnography. The all-pervading influence of nature forms and shapes peoples, nationalities, and their customs and habits; and therefore ethnology must become a natural science,—the physical science of the mind as manifested in the development of each nation in particular, and all the nations taken as a whole. The withdrawing of ethnology from metaphysical influences, under which it has labored since it was made a scientific study, is

possible only when a sufficiently large material has been collected among the nations of the globe and the records of history to establish on it incontrovertibly general principles, which will be found to rest on natural science, and not on philosophic speculation. Some parts of the vast field of ethnology are still obscure as to their real significance, because the material to judge from is too scattering and scanty. Bastian's most recent work contains a series of seven articles, mainly on Polynesian subjects, which uphold and illustrate his ideas concerning ethnology, as stated above, with a full array of the most erudite comparisons. The author's extensive travels have furnished him with a stock of ethnographic facts which none has equalled in our century, and which he readily compares on almost every page with notices derived from the classic writers. Concerning the progress traceable on the social development of man, the writer shows, that, considered as an individual, the single man is of very small account in the primitive horde. The first stage is the tribe, based on consanguinity with exogamic marriage. This stage passes into that of *civitas*, or citizenship, whenever the country becomes agricultural. Social connection is no longer determined by family ties, but by the extent of the district, country, or commonwealth to which the individual belongs. When tribal organization becomes loose, then blood-revenge, and similar primeval customs, also disappear. The concise style of Bastian is not always what we should desire: at times it becomes rambling, a heavy phraseology obscures its lucidity, and the pressure of thoughts cannot find words enough to give vent to their rapid flow. Such defects as these are more prejudicial to the literary success of Bastian's numerous publications than the typographic errors which the proof-reader has allowed to disfigure their texts, especially the classic quotations.

STOKES'S SCIENTIFIC PAPERS.

Mathematical and physical papers. By GEORGE GABRIEL STOKES, M. A., D. C. L., LL. D., F. R. S., professor of mathematics in the University of Cambridge. Reprinted from the original journals and transactions, with additional notes by the author. Vol. ii. Cambridge, University press, 1883. 366 p. 8°.

VOL. i. (328 pages) appeared in 1880, and contains the papers, arranged in chronological order, which were published by the author between April, 1842, and December, 1847. The earliest date in vol. ii. is March, 1848, and

the latest, March, 1850. Vol. iii. is stated by the publishers to be in press.

Of the papers reprinted in these first two volumes, only two of the more important are of a purely mathematical character, and these treat of the properties and methods of computation of infinite periodic series such as arise in many physical problems, which series were first systematically employed and explained by Fourier in 1822. Fourier's treatise¹ is to-day the best introduction to a knowledge of this kind of analysis, besides being one of the most brilliant expositions, in any branch of science, in existence. With the exception of a single paper of 42 pages, upon a differential equation relating to the breaking of railway bridges under loads moving at high speeds, the remaining papers all come under the head of fluid motion in one way or another, and include extensive discussions of the fundamental dynamical equations of motion of perfect fluids, of viscous fluids, and of elastic solids. These discussions treat, among other subjects, the theory of oscillatory waves, the equilibrium of the earth in a fluid state, the variation of the force of gravity on its surface, and the undulatory theory of light.

The work of Professor Stokes in hydrodynamics is of special importance in correcting and rediscussing the results obtained by Lagrange and Poisson, and in paving the way for the more modern developments of Helmholtz and Thomson in vortex motion, and of Maxwell in electricity and magnetism.

¹ Analytical theory of heat. By JOSEPH FOURIER. Translated, with notes, by Alexander Freeman. Cambridge, 1878.

But the papers of Stokes which are probably of most interest to the mathematical physicist of to-day are those upon the undulatory theory of light, in which he has added essentially to our knowledge of the constitution of the luminiferous ether by showing how the phenomena of aberration may remain unaffected by the fixity or motion of the ether, as also by his investigation of the theory of diffraction, by which he has sought to decide whether the vibratory motion of a plane polarized ray lies in the plane of polarization or at right angles to it.

By these investigations, and by others, among which may be noticed that of the colored rings of Newton, he has explained difficulties in Fresnel's undulatory theory, and essentially improved it.

The treatise of Verdet,¹ which is the most complete and important exposition of the undulatory theory yet written, gives a complete bibliography of this subject, extending to many hundred titles, from which the reader can correctly estimate the labors of Professor Stokes in this field.

The lifelong labors of Professor Stokes have given an immense impulse to mathematico-physical research in England; and the republication of these papers by the syndics of the Cambridge university press is a graceful and well-deserved tribute to the Nestor of the greatest mathematical school in the world.

¹ *Leçons d'optique physique* par E. Verdet. Paris, tome i., 1869; tome ii., 1872. The following translation and revision to date is in process of publication: *Vorlesungen über die wellentheorie des lichtes*, von E. Verdet. Herausg. von Dr. Karl Exner, Braunschweig. Bd. i. 1881.

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Geologic work in the South Atlantic district.—Owing to the as yet incomplete state of the topographic work in the southern Appalachians, the systematic geologic survey of that section has not yet been commenced. However, several geologic reconnaissances have been made, and considerable collections of paleontologic material have been sent into the main office of the survey. During the season of 1883 Prof. H. R. Geiger examined the geologic structure of a considerable portion of Virginia and West Virginia. During the latter part of July he was in the eastern part of Virginia, but in August transferred his field of work to Greenbrier county, W. Va., where he studied the formations that are exposed between the Greenbrier River and the Lewis Tun-

nel, just east of Alleghany station, W. Va. A collection of Devonian fossils was made. In September his work was carried into Alleghany county, Va., where a careful examination was made of the rocks so well shown there. The thickness, dip, etc., of the beds were obtained, and an excellent series of typical specimens secured. In October the field was extended northward to Rockingham county, but bad weather impeded the operations. Through November a special study was made of the foldings in the limestones that lie between the Blue Ridge and North Mountain, and a careful comparative examination made of the limestones of Rockingham and Rockbridge counties, Va.

Professor Ira Sayles was assigned to the north-eastern part of Tennessee, and adjacent portions of Virginia and Kentucky. The early part of July was spent by him in the examination of the caves near

Clinch River in Virginia. He next examined the coal-beds on Big Yellow Creek in Bell county, Ky., and the Dyestone iron-ore beds a few miles farther down Poor valley. The following month the work on Clinch River was continued in Hancock county, Tenn., especially with the object of ascertaining and more accurately defining the extent and direction of the faulting so well displayed in that section. The upper coal-measures were also examined, and a running field-chart of the county made. In the latter part of the month, Professor Sayles discovered some very interesting cave-deposits in a quarry in Hawkins county, Tenn. The formations of this county were carefully studied during September and October, and large collections of fossils obtained. The latter part of October found Professor Sayles at Knoxville, in accordance with his orders, to examine the vicinity of Knoxville and Centreville for Potsdam fossils to supplement Mr. Walcott's paleontologic work. He was engaged in this region through November and December.

Topographic work in eastern Tennessee. — With a view to facilitate future geologic work, the division for the topographic survey of the southern Appalachian region was organized upon a considerably enlarged scale for the season of 1883. As already noted in *Science*, five topographic and two triangulation parties were put in this field.

Topographic party No. 3, in charge of Mr. Frank M. Pearson, was assigned to the valley of East Tennessee. The territory covered by his party includes about five thousand square miles, lying between parallels 36° and $36^{\circ} 35'$, and between meridians $82^{\circ} 15'$ and $84^{\circ} 30'$. This area is the northern half of the valley of East Tennessee; extending from the summit of the Cumberland Mountains and Cumberland plateau, on the north and west, to the summit of the Smoky Mountains, or state line between North Carolina and Tennessee, on the south and east. The topographical character of this region is such that the methods of work employed in the west had to be somewhat modified. It was necessary to carry on a considerable part of the work by means of compass meander-lines; and the rapidity of this class of work, and of the triangulation, was seriously interfered with on account of the dense timber which prevails everywhere, and by the atmospheric conditions, which are rarely favorable for clear views of any great extent. The prominent topographical features are peculiar. Almost the entire main valley is occupied by parallel ridges, that have their origin in south-western Virginia, and run in a south-westerly direction through Tennessee, and into Alabama and Georgia. In this, of course, the drainage system is simple, the larger streams, with few exceptions, being confined by the ridges which enclose their head waters.

The Bays Mountain, consisting of a great number of these parallel ridges, or mountains, as they are wrongly called, constitutes the divide between the Holston River on the west, and the Nolachucky and French Broad Rivers on the east. In the vicinity of this mountain, and on either side, the drainage is almost entirely underground, the water flowing

through and in the limestone strata that underlie this region. This renders the tracing of the streams a difficult matter. The minor drainage collects in numerous sink-holes, which occur on the broad divides from which the streams flow in underground channels, and come to the surface again in unexpected places, and frequently at considerable distance from the point of disappearance. A striking example of this kind of drainage is seen in Mossy Creek, which is also interesting from the luxuriant growth of confervoids and moss with which its bed is covered. This stream rises on the north slope of Bays Mountain, and, after a course of three miles, disappears, and is not seen as a surface-stream for a distance of seven miles, when it re-appears, and flows for three miles to its junction with the Holston River. Five miles from the source of the stream there is a so-called sink-hole, which is six hundred feet in length and of unknown depth. A ninety-foot pole does not touch the bottom. This is really a surface appearance of the stream. A saw-mill was located on the creek a short distance above the first point of disappearance; and the people of the country have frequently noticed that slabs and saw-dust from the mill would rise to the surface in this sink-hole, then disappear, and come to the surface again in Mossy Creek, three miles above its mouth, where it rises for the last time.

Mr. Pearson says that the topographical unity of the ridges and valleys is not recognized by the inhabitants of the country, and hence some confusion has arisen. To the same ridge or valley, often only fifteen or twenty miles in length, as many as five different names are frequently applied; the universal custom being to re-name a ridge or valley whenever it is cut in two or crossed by a stream. This confusion of names also arises partly from the fact that no thorough or connected survey of the region has ever been made, although it is one of the earliest settled portions of the United States.

The natural water-power facilities of the Appalachian region have recently been the subject of much notice, and in this respect the valley of East Tennessee is unexcelled. There are in it many streams of considerable length, affording abundant water-power, that are not indicated on even the best existing maps of the region. Other additions and corrections of considerable importance have been determined by the work of Mr. Pearson.

PUBLIC AND PRIVATE INSTITUTIONS.

Museum of comparative zoology.

Arrangement of exhibition-rooms. — The exhibition-rooms are comparatively small, each one devoted to a special subject, but so combined, that, when taken together, they illustrate the animal kingdom as a whole, in its general relations and in its geographical and paleontological range and distribution. They are intended not only to meet the wants of the public at large, and of beginners as well as of more advanced university students, but also to promote research by giving assistance to specialists and original investigators. Meanwhile the work of the mu-

seum proper should be in charge of assistants whose duties are so arranged as to leave a good part of their time free for original research; the museum as a whole forming an important branch of the natural-history department of the university, with which its assistants and professors are intimately connected.

An enumeration of the contents and uses to which the space is devoted will give a better idea of the aims of the museum than a lengthy description.

Exhibition-rooms.

Synoptic room: synopsis of the animal kingdom, living and fossil.

Five systematic rooms for the systematic collections of mammalia, birds, fishes, mollusca, radiates, and protozoa; and their galleries for reptiles, insects, and crustacea.

Seven faunal rooms and galleries: North American, South American, African (including Madagascar), Indian, Australian, Europeo-Siberian,¹ Atlantic,¹ Pacific.¹

Four rooms for the paleontological collections.

Two rooms for the paleozoic, one for the mésozoic, and one for the tertiary, as follows: Silurian and Devonian,¹ carboniferous and Jura,¹ cretaceous,¹ tertiary.¹

The work-rooms for the assistants of the museum, and the storage-rooms, which are also intended as work-rooms of their special subjects, are distributed as follows, in addition to a large receiving-room and a general workshop:—

The alcoholic collections stored in the basement occupy four rooms devoted to fishes, two rooms for fishes and reptiles, one room for birds and mammals, one room for mollusca, one room for crustacea, one room for the other invertebrates.

The entomological department is to occupy eventually four gallery-rooms of the first story.

The work rooms and storage-rooms of the fifth story are filled by collections occupying five rooms devoted to birds and mammals, three for skins and eggs and two for skeletons, one for crustacea, one

¹ Not yet open to the public.

for mollusca, one for fish and reptile skeletons, one for the collection of dry invertebrates (corals, echinoderms, sponges, etc.), two for fossil vertebrates (exclusive of fishes).

The remaining paleontological collections are crowded into four work and storage rooms. There are two work-rooms for the geological and lithological department. Four rooms are devoted to the library of the museum, and one room for the office of the curator. There are also a large general lecture-room, three laboratories for students in biology, three laboratories for students in geology and paleontology, with two smaller private rooms for the instructors. With the biological laboratories will be connected also a large room for an aquarium for both fresh-water and marine animals, and another room for a vivarium, both of which are in the basement of the building.

This will give, in all, seventeen rooms devoted to the exhibition of collections for the public; ten work and storage rooms in the basement, for the alcoholic collections; thirteen work and storage rooms for the dry zoölogical collections; eight similar rooms for the paleontological and geological collections; and thirteen rooms devoted to the laboratories, lecture-rooms, and library connected with the instruction given at the museum; the arrangement being such, that, whenever any departments (as, for instance, the geological and geographical, or the anatomical, or any other) outgrow their present quarters, room can be made for them by extensions of the building, for a long time to come, without interfering with the plans which have been carried out thus far.

In adopting a small unit for the size of the rooms (30×40 feet), all attempts at exhibition-rooms, imposing from their size, were deliberately abandoned. It is aimed only to place before the public such portions of the collections as shall become instructive; and in the storage and work rooms the appliances for storage aim at economy of space, and are intended, while they do not neglect the careful preservation of the collections, to give to the assistants and students the freest and quickest possible access to them.

RECENT PROCEEDINGS OF SCIENTIFIC SOCIETIES.

Cambridge entomological club.

Feb. 8. — Mr. G. Dimmock called attention to some curious habits of the common European earwig, *Forficula auricularia*, a specimen of which he had kept in confinement several months. These insects are omnivorous, but apparently prefer insects as food, eating their own species greedily. Although to all appearances blind, except to the presence or absence of light, the specimen above mentioned captured fleas (*Pulex irritans*) with ease in an enclosure about five centimetres in diameter. No notice was taken of a flea put in the enclosure until the flea actually touched the earwig, when the latter would rush after the flea,

palpitating with the antennae rapidly, and thus keeping on his track. If the flea escaped from beneath the antennae of the earwig, the latter would find him again in a moment, and the amusing chase would be renewed, to end in the sure seizure of the flea in the mouth-parts of the earwig. The earwig was a glutton, and would often eat a large number of fleas or other insects in succession, at the end of his repast his abdomen being much distended. — Mr. S. H. Scudder exhibited a specimen and drawings of an arachnid from the coal-measures of Arkansas. Two years ago Karsch figured a similar form from the coal of Prussian Silesia, under the generic name *Anthracomartus*, and Kušta has just described another from carbo-

niferous beds in Bohemia. This adds another to the many instances in which a new generic type of carboniferous arthropods had no sooner been announced as found on one continent than it was discovered on the other. The Arkansas species was obtained by Prof. F. S. Harvey of Fayetteville, and had not been in Mr. Scudder's hands a month before a second American species was found by Mr. R. D. Lacoe in the well-known beds of Mazon Creek, Ill.

Biological society of Washington.

Feb. 8. — Mr. W. T. Hornaday read a paper on the guacharo bird of Trinidad, describing the habits of the *Steatomis caripensis* as observed by him in one of the caves where it breeds. — Mr. G. Brown Goode read a paper on the aims and limitations of modern fish-culture. Modern fish-culture he defined to be fish-culture carried on upon an immense scale, under the direction of men trained to scientific research, as distinguished from the old and insignificant method of fish-culture carried on by private enterprise. Its aims were shown to be, 1, to arrive at a complete understanding of the life-histories of useful aquatic animals, and the conditions under which they live; and, 2, to apply this knowledge so thoroughly that all fishes shall be brought as completely under control as are now the shad, the salmon, the carp, and the whitefish. The limitations of fish-culture were shown to be the same as those of scientific stock-rearing or agriculture. — Dr. T. H. Bean made a communication upon an augmented development in the fins of a species of *Siphostoma*, exhibiting a specimen with a supernumerary anal fin. In the discussion of this paper, Mr. John A. Ryder remarked that this deformity was an attempt toward reversion to the condition of some remote ancestral type in which there was a continuous fin around the posterior portion of the body. — Mr. C. D. Walcott exhibited a specimen of trilobite, *Asaphus* sp., in which twenty-six pairs of legs, and the mouth-parts also, were plainly to be seen; also a specimen of Maine granite containing fossil corals, probably of the Devonian age.

Philosophical society of Washington.

Jan. 19. — Mr. Israel C. Russell made a communication on the existing glaciers of the high Sierra in California. After showing the extent of the ancient glaciers of the region, and their relation to the topography, he described in detail the phenomena of the Mount Dana, Mount Lyell, and Parker Creek glaciers, closing his remarks with a reference to the literature of the subject. The Mount Dana glacier lies at the foot of a cliff on the north face of that peak, with an elevation of 11,500 feet above the sea. It is at the head of a deep cañon draining into Lee-Vining Creek, one of the tributaries of Mono Lake. It is approximately 2,500 feet long, and of somewhat greater breadth. Notwithstanding its small size, the distinction between the snow-ice of the *névé* and the solid greenish-blue ice of the glacier proper is clearly marked. Its planes of growth are indicated by a banded structure,—compact ice alternating with thin sheets of porous white ice and with dirt-bands.

It is abundantly provided with crevasses, and has a terminal moraine visibly growing. The stones of the moraine show marks of attrition, and the lakelet fed by the outflowing stream is milky from suspended detritus. The Mount Lyell glacier is somewhat larger, and exhibits substantially the same characters. A portion of its surface is characterized by 'ice-pyramids.' These occur only near the foot of the glacier, where the surface is rapidly melting, and depend upon the power of superficial pebbles to rescue the ice immediately beneath them from the porosity elsewhere produced by insolation. The Parker Creek glacier, likewise at the head of a tributary of Mono Lake, resembles the others in its general features, and displays in addition a considerable number of 'glacier-tables,'—blocks of rock perched on standards of ice. A number of other glaciers were seen at a distance of a few miles, but were not visited. The various phenomena were illustrated by photographs.

Mr. Gilbert Thompson described certain glaciers on Mount Shasta believed to be new to science. Their discovery increases the number of known glaciers on the flanks of Shasta to seven. Mr. W. H. Holmes described the glaciers of the Wind River Mountains, and the glaciers of Mount Moran in the Teton Range. The former are from one-fourth of a mile to one mile in length. The latter are three in number, and lie at an altitude of 12,000 feet. Mr. Mark Kerr mentioned the occurrence of a glacier in the Salmon Mountains, a division of the Coast Range.

Prof. W. C. Kerr described the mica-mines of North Carolina, explaining their geological relations, and setting forth the economic and mineralogic results of their exploitation. He described more particularly a series of prehistoric excavations, which are large and numerous, and were evidently made for the purpose of obtaining the same mineral. One of these measures 150 by 75 feet, and, despite a partial filling with *débris*, retains a depth of 35 feet. The ancient work was performed with blunt-pointed tools, doubtless of stone; and facts connected with the arboreal vegetation show that it had been discontinued as much as five hundred years ago.

Scientific club, Manhattan, Kan.

Jan. 18. — Mr. Shartel presented some notes regarding the Suez and Panama canals and the Augsburg tunnel. Mr. Marlatt described a worm which he observed last year. Professor Kellerman made some interesting remarks respecting the occurrence of chlorophyll in animals. Superintendent Graham gave a description of some carvings on a rock in a cave in Greenwood county. These carvings were observed by Mr. Mason, and drawings which he made of them were exhibited. Mrs. Kellerman gave an interesting description of the Termites, or 'white ants.' She described their manners and customs, grades of society, architecture, political economy, and many other points. Mr. Lund read a paper on the undulations of the earth's surface. He cited numerous instances of elevations and depressions that are

taking place at the present time, as well as some of the more remarkable ones of past ages.

Cuvier club, Cincinnati.

Jan. 5. — In their annual report, the trustees stated that the club expended during the year \$238.60 in the prosecution of the game-laws. The extension of the open season for quail through November was suggested as not likely to do injury; and attention was called to the continued pollution of waters, and the consequent destruction of fish. The necessity was urged of protecting the National park from the speculator, and such tracts as the Adirondacks from the wood-chopper.

Academy of natural sciences of Philadelphia.

Dec. 11, 1883. — In an account of the formicaries of the carpenter ant, the Rev. H. C. McCook related observations proving that the females of *Camponotus pennsylvanicus*, when fertilized, go solitary, and, after dispossessing themselves of their wings, begin the work of founding a new family. This work they carry on until enough workers are reared to attend to the active duties of the formicary; as, tending and feeding the young, enlarging the domicile, etc. After that, the queens generally limit their duty to the laying of eggs, and are continually guarded and restricted in their movements by a circle of attendant workers, or 'court.' The facts are further illustrated and enlarged by a series of observations made by Mr. Edward Potts, in accordance with the speaker's suggestions and directions. They establish or confirm the following points: 1. The manner of depositing the eggs, which, as well as the larvae, are cared for by the queen until workers are matured; 2. The stages in the development of the egg and larvae are partially noted; 3. The time required for the change from larval to pupal state is about thirty days; 4. About the same period is spent in the pupal state, the entire period of transformation being about sixty days; 5. The work of rearing the first broods begins the latter part of June, or early in July; 6. About twenty-four hours are spent by larvae in spinning the cocoon; 7. The ant-queen probably assists the callow antling to emerge from its case; 8. Not only the larvae, but occasionally the antlings, are fed by the queen; 9. The young workers, shortly after emerging, begin the duty of nurses, caring for the eggs, and tending the larvae.

Jan. 1. — Professor Joseph Leidy exhibited specimens of tin ore from the Black Hills, Dakota. They consisted of a mass of granite containing cassiterite, a fragment of quartz with the same, and a mass of pure cassiterite of about one-pound weight. He had also seen several pounds of large grains obtained from gold-washings. From among these he had picked out several characteristic crystals.

NOTES AND NEWS.

THE death, last Friday, of Professor Arnold Guyot of Princeton, removes one more of those distinguished men of broad scientific culture, who, nurtured in

Europe, have given the best fruits of their lives to America. His influence on the young men under his teaching was second only to that of his devoted friend and countryman, Agassiz. We shall speak more at length of his life and characteristics in a future number.

— It will be a source of pleasure to those who are aware of the reliable and conscientious character of Dr. Joseph Leidy's contributions to science, to learn that he has been awarded by the Geological society of London the 'Lyell medal,' with its accompanying purse of twenty-five pounds, in recognition of his important services to paleontology. In a letter received from Warrington W. Smith, foreign secretary of the Geological society, dated Jan. 25, Dr. Leidy is advised of the award, and requested to depute some fellow of the society to receive the same at the anniversary meeting to be held on the 15th inst., for transmission to Philadelphia.

— The fourth volume of the census reports has been issued from the press. This is upon the 'agencies of transportation,' and includes the statistics of railroads, steam-navigation, canals, telegraphs, and telephones. Naturally the first of these subjects takes up the bulk of the volume, monopolizing 651 pages out of a total of 869. The statistics and discussion of this subject, as well as of telegraphs and telephones, have been prepared by Mr. A. E. Shuman, whose thorough acquaintance with the subjects, and whose painstaking care, are amply illustrated by the reports in question.

The total railroad mileage in operation on June 1, 1880, is given as 87,781 $\frac{97}{100}$. This was under the management of 631 corporations. The total cost of construction was \$4,112,367,176, and of equipment, \$418,045,458. The assets of the whole system amounted to \$5,536,419,788, and the liabilities, \$5,425,722,560. The paid-in capital stock aggregated \$2,613,606,264, over 80% of which earned a profit at an average rate of 6 $\frac{33}{100}$ %. The total number of stockholders (estimated, in part) was not far from 300,000, giving an average of \$8,700 of stock to each. The aggregate freight mileage was 32,348,846,693, and the passenger mileage, 5,740,112,502. To illustrate the amount of railroad travel, it may be said that this represents an average travel of 114 miles for each man, woman, and child in the country. The above figures, when contrasted with those representing the condition of the railroad interest in this country at the close of 1882, show an immense growth during the two years and a half. At the latter date there were in operation not fewer than 117,717 miles, an increase of 29,835 miles, while the capital had increased in approximately the same proportion. At that date the total railroad mileage of the globe is given (Spofford's Almanac) as 264,826, of which this country owned over 44%. The total of all Europe was less than that of the United States, being but 105,895. The statistical tables of the report upon railroads contain, 1°, a general financial exhibit of the several roads; 2°, a general balance-sheet; 3°, traffic operations; 4°, passenger and freight mileage; and,

5°, equipment and employees. A second portion of the report relates to the physical characteristics of the roads, with statistics regarding the history of construction, grades, curves, roadway, and tracks. This is followed by an analysis of the funded debts of railroad corporations, and by a statement regarding the amount and kind of fuel used. The report concludes with a condensed statement of the agreements existing between different railroad companies, and between these companies on the one hand, and express and sleeping car companies on the other.

The report by Mr. T. C. Purdy, upon steam-navigation, opens with a history of that subject, in which the progress of development of the species, the highest type of which is our ocean-going steamship, is briefly sketched. The tables show the number, tonnage, value, capital invested, service, and traffic of our steam-craft. The report upon canals, by the same author, opens with a history of canal construction in this country. Many persons at the present day will doubtless be surprised to learn the extent to which this class of internal improvements was pushed during the period between 1825 and 1840. The total length of canals constructed in this country was 4,468 $\frac{1}{10}$ miles, costing \$214,041,802. Of this, 1,953 $\frac{6}{10}$ miles have been abandoned, and a large part of the remainder is not paying expenses. The statistics connected with this report give financial statements, date of construction, dimensions of canals, and the number and dimensions of locks.

The report upon telegraphs opens with a brief discussion of the statistics. The tables contain a general financial exhibit, a statement of volume of business, number of employees, and description of lines. The report upon telephones is of a very similar character. In regard to this, it should be borne in mind that the telephone was in its infancy during the year to which the statistics refer, and that its use has increased enormously during the years which have elapsed since. Following this report is a paper upon the postal-telegraph service in foreign countries, which cannot fail to prove of great interest at this time, when the question of a government telegraph is being actively agitated in this country. This report has been compiled by Mr. Robert B. Lines, mainly from information received from the heads of the departments of postal telegraph of foreign countries through our representatives. It details the history of the postal telegraph in each country where it exists, sketches the methods of business management, and compares the administration by the government with that by private hands, both as to cheapness and efficiency. The following countries support telegraphs which, either wholly or in part, supplant private undertakings: Great Britain, Germany, France, Austro-Hungary, Russia, Switzerland, Belgium, Netherlands, Sweden, Norway, Denmark, Portugal, Roumania, Turkey, Brazil, Japan, Canada, and New Zealand,—in short, nearly every civilized country. In most cases the telegraph has been the property of the state since its introduction, but in a few cases the property has been purchased from private owners. This was the case with Great Britain,

who bought out the telegraph companies in 1870. The price paid for the property was based upon the net earnings in the year ending June 30, 1868, by capitalizing that amount at five per cent. The transfer from private to public hands has been found to be advantageous; as not only have the rates been largely reduced, but this department has been more than self-supporting, having earned in twelve years (from 1870 to 1881 inclusive) the sum of £1,996,996. This, however, need not be a matter of surprise; as the uniform rate for twenty words is one shilling (twenty-five cents), and threepence for each additional five words or part of five words. As compared with the rates of private corporations in this country, these rates are but little lower for equal distances, while, if we consider the greater density of population and the vastly greater volume of business done in England, it would seem that these rates are relatively quite as high. In most of the continental countries rates are less; and, in all cases where the statistics are given, the expenses of the department have been greater than the receipts.

The volume has a very full general index.

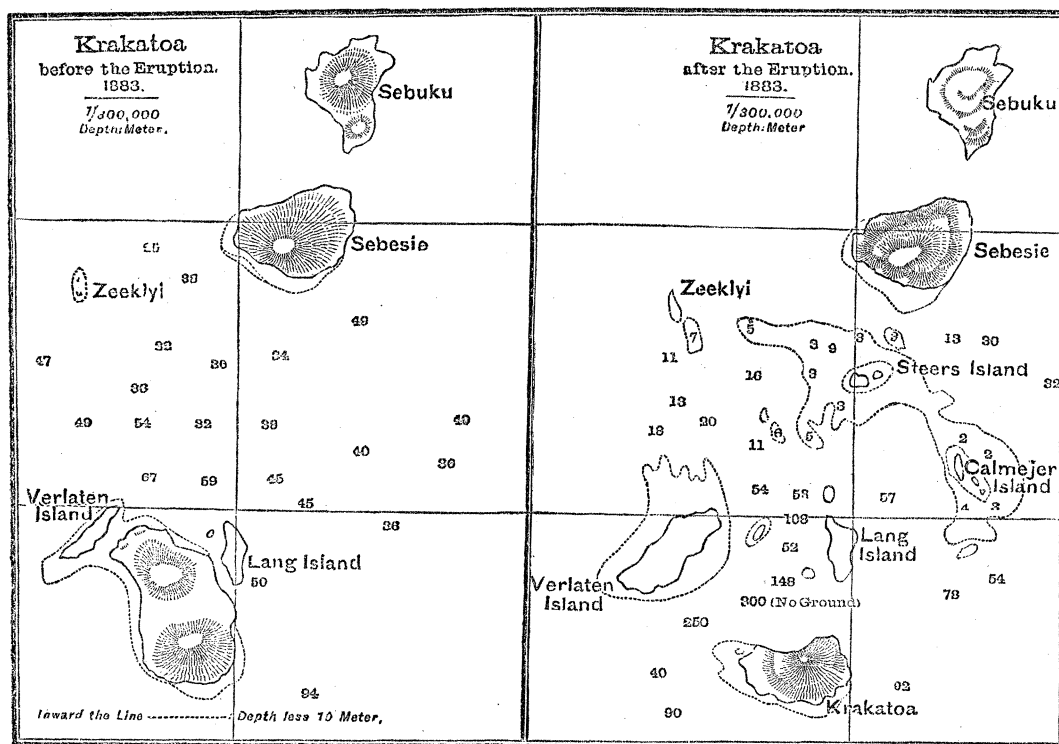
—Wedenskii states (*Centralbl. med. wiss.*, 1883, 465) that he has been able to demonstrate the presence of the negative variation of the natural nerve current in a stimulated nerve by means of the telephone in a way similar to that described by Bernstein and Schönlein for the muscle. The quality of the 'nerve-tone' obtained does not differ from that of the telephonic muscle-tone. When, by tying a string around it, the physiological continuity of the nerve was destroyed, the peculiar nerve-tone caused by interruptions of the negative variation current disappeared, while that caused by unipolar action, and of a purely physical origin, could still be heard. The latter tone, however, could be distinguished from the true physiological nerve-tone both by means of its peculiar quality and by the fact that it required a greater strength of stimulus for its production than the former. Chemical and mechanical stimulation were also tried, and in each case a definite noise was heard. When the nerve was stimulated by means of a constant current, a peculiar noise was heard, in accordance with the law of contraction, either at the opening or the closing of the current.

—E. and F. N. Spon announce A pocket-book of electrical tables, for the use of electricians and engineers, by John Munro and A. Jamieson; Absolute electrical and magnetic measurements, reprinted from *Nature*, by A. Gray; Handbook of sanitary information for householders, by Roger S. Tracy.

—The deaths are announced of Mr. Hugh Powell, the first English optician to construct objectives on the water-immersion principle, and one of the founders of the Royal microscopical society, of whom only five now remain; and of the venerable Professor Sven Nilsson of Lund, known for his zoological work and his investigations on the prehistoric inhabitants of Scandinavia.

—A correspondent of *Nature*, who has evidently had a good opportunity to study the results of the Krakatoa eruption, and has made soundings in the neighborhood, writes, that instead of the sixteen new volcanoes which were at first reported, and the total destruction of Krakatoa, there is still a considerable portion of the island, and that the greater part of the destruction seems to have come from the wave produced by the eruption and the fall of the masses of material which were thrown from the northern portion of the island. Krakatoa at its northern end now rises in a steep wall eight hundred metres high; and,

of his resigning the superintendency of the natural-history section of the British museum. Although about eighty years of age, he is still vigorous, and reads papers before the learned societies at nearly every meeting. The establishment of a natural-history museum was long an object for which he toiled. Over twenty years ago he published an address 'on a national museum of natural history,' in which he stated his view relative to the need for, and the proper organization of, such an institution. The new museum is in a large degree the result of his labor.



where was once land, soundings of three hundred and sixty metres have been made without finding bottom. A large portion of this material appears to have been deposited a few miles to the north, as shown in the map, by the new islands of Steers and Calmejar, and the shoals to the north of Lang Island, which seems to have been about on the line between the upheaval and downfall, and has not been changed materially in size. All the islands are covered with ashes; the destruction of life having been nearly complete, even in Sebuku, the first patches of green showing themselves on the small islands farther north.

—Professor Richard Owen has ceased to be a commoner, having been knighted by the Queen. A banquet was given him by his colleagues on the 21st of January, as a sort of farewell celebration on the event

—The annual course of lectures given under the auspices of the University of Pennsylvania consists this year of The development of the house, by Rev. R. E. Thompson; Why doctors exist, and how they work, by H. C. Wood, M.D.; First aid in emergencies, by J. W. White, M.D.; Order and progress, by Mr. A. S. Bolles; The romance and realities of animal locomotion, by Mr. E. Muybridge; A glance at the lowest forms of life, by J. Leidy, M.D.; Chemistry in the industrial arts, by Mr. S. P. Sadtler; The creation of an empire, or, The life and work of Count Otto von Bismarck, by Mr. E. J. James; Relation of American forests to American prosperity, by J. T. Rothrock, M.D.; How electricity is measured, by G. F. Barker, M.D. The course began Jan. 11; and a lecture will be given every Friday evening till March 21, except on Feb. 22.

— Charles Scribner's Sons announce an important book, by Professor Arnold Guyot, entitled "Creation; or, The biblical cosmogony in the light of modern science."

— The Pilot chart of the North Atlantic Ocean for February shows a smaller number of wrecks than were given on that of last month. The thick scattering of wrecks along our coast from Cape Hatteras to New York, and on the January chart farther north, as compared with those charted on the European coast, attracts immediate attention, but may be due to the more complete information received by the hydrographic office from vessels entering American ports, rather than to greater carelessness or recklessness on the part of American navigators.

— Dr. H. Laspeyres has been appointed professor of mineralogy in the university at Kiel, and Dr. F. Kurtz of Berlin, professor of botany at the university at Cordoba in the Argentine Republic.

— Over a million visitors passed the turnstile of the South Kensington museum during 1883; and since the opening of the museum in June, 1857, the number of visitors is stated to have been 22,675,912.

— The course of 'practical lessons' in anthropology, of the Parker memorial science class, began Jan. 6, and will continue to March 30. Among the subjects of the essays to be discussed we find 'Infant education,' 'Language and its evolution,' 'Heredity,' and 'Allopathy vs. homoeopathy.'

— The annual watch-trials undertaken at the Yale college observatory for the encouragement of horology are now in progress, and watches or marine chronometers whose record is to appear in this year's observatory report will be received not later than April 15. The report is published the latter part of June. Full particulars of the conditions of the watch-trials will be furnished upon application to the secretary of the observatory.

— Dr. Benjamin Sharp has been appointed professor of lower invertebrata by the council of the Academy of natural sciences of Philadelphia. Dr. Sharp is a graduate of the University of Pennsylvania, from which he received the degrees of Doctor of medicine and Doctor of philosophy in 1881. He afterwards studied under Leuckart in Leipzig, and under Semper in the University of Wurzburg. He took his degree from the latter after presenting a thesis in German on the anatomy of *Ancylus*. A translation of this memoir has been published in the proceedings of the academy, and is considered an important addition to our knowledge of the group of animals described. Dr. Sharp was granted the privilege of studying at the Bavarian table in the Zoölogical station at Naples, an honor rarely granted a foreigner. Dr. Sharp proposes delivering lectures, during the coming spring, on the lower forms of life. The course will, in some degree, supply the lack of biological instruction in Philadelphia, which has recently been the subject of public comment.

— Barnum's 'white elephant' arrived at the Zoölogical gardens on Jan. 17, since which time it has attracted much attention. 'To call the elephant 'white'

is certainly to use that term in a very broad sense. The general color of the animal, which is a male about seven feet high, is a light gray, perhaps a shade lighter than is usual. The only parts which approach white are the tips of the ears, the breast, a space in front of and behind the eyes, the middle of the forehead, and a space under the ears. The color in these regions is a sort of dull fleshy tint, although the blotch on the forehead has a brownish tinge. The blotches are very irregularly margined, and plentifully sprinkled with small spots of the normal gray of the body. A much more remarkable feature than these slight irregularities of color is the length of the tail: the tuft at its extremity all but touches the ground. The elephant appears to be in excellent condition, and has fine pointed tusks.

— Upon the resignation of Professor (now Sir) Richard Owen from the superintendency of the British museum, the trustees of that institution have unanimously chosen Professor William H. Flower, LL.D., F.R.S., F.Z.S., etc., to be his successor. In accepting this position, Professor Flower will probably sever his connection with the Museum of the Royal college of surgeons, of which he has been for a number of years the conservator. In the latter position he also succeeded Professor Owen.

The election of Professor Flower to the prominent and responsible post of superintendent must be regarded as a very happy occurrence. His numerous contributions to mammalogy (especially to the knowledge of the cetacea) and to other branches of zoölogy entitle him to the high rank which he holds in England and throughout the scientific world. His administrative ability is amply displayed in the perfection to which he has brought the arrangement of the collections of the Royal college of surgeons.

The keepers of the several departments of the Natural-history museum who are next in rank to the superintendent are as follows: keeper of zoölogy, Dr. Albert Günther; assistant, Arthur G. Butler; keeper of geology, Dr. H. Woodward; assistant, R. Etheridge; keeper of mineralogy, L. Fletcher; keeper of botany, W. Carruthers.

Professor Flower is at present engaged in the preparation of a series of lectures on anthropology, to be delivered in the coming spring; in the publication of a complete catalogue of the collection of the College of surgeons; and of numerous scientific papers of importance, notably, one upon the Delphinidae.

— The sixth fasciculus of Dr. Fisher's *Manuel de conchyliologie* has appeared, carrying the work from Siphonaria, through the opisthobranchs, nucleobranchs, and to the beginning of the prosobranchs, including the *Toxoglossa* and *Rhachiglossa* as far as the *Volutidae*. The character of the work is fully maintained, or, if any thing, becomes more satisfactory as the better-studied groups are taken up. About three-fifths of the work has now appeared.

— *Papilio*, a journal devoted solely to Lepidoptera, and published for three years as the organ of the New-York entomological club, under the superintendence of Mr. Henry Edwards, is to be transferred to Philadelphia, and edited by Eugene M. Aaron.